SN: 734-5

POWER SUPPLY
INSTRUCTION MANUAL

MODEL	CS36 CR 30-D2

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INSTRUCTION MANUAL

FOR NJE CUSTOM MODEL

CS36CR30-D2

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WARNING

THIS EQUIPMENT EMPLOYS VOLTAGES WHICH ARE DANGEROUS AND CAN BE FATAL IF CONTACTED BY OPERATING PERSONNEL. EXTREME CAUTION MUST BE EXERCISED WHEN WORKING WITH THIS EQUIPMENT.

INTRODUCTION

CORRESPONDENCE

All correspondence must reference the complete description of the unit as shown on the identification label located at the rear of the unit.

In requesting spare parts or information relative to parts, the Reference Designation, the rating, the description and the NJE Part Number must be specified for each part in question.

DESIGN IMPROVEMENTS

N.J.E. Corporation reserves the right to make design improvements on any instrument without prior notice.

REPRODUCTION

No material, drawings, text, figures or any part of this instruction manual may be reproduced without express written consent of N. J. E. Corporation.

REPAIR SERVICE

N.J.E. Corporation provides complete repair facilities at the main plant and at local service centers as listed on the back of this manual. These repair facilities are adequately staffed with factory trained technicians to assure our customers of the most knowledgeable and expedient servicing of our equipment. All equipment forwarded to these facilities must be adequately packaged to prevent damage in transit.

OUT OF WARRANTY SERVICE:

Forward defective equipment to factory or local service center prepaid. A full description of difficulties encountered or the repair required should accompany this shipment. An estimate of the cost of repair will be submitted to you. The necessary servicing will be performed only upon receipt of your written service orders. Your equipment will be returned to you via collect shipment unless otherwise specified on your service order.

IN WARRANTY SERVICE:

If during the warranty period the power supply indicates an inherent defect, immediately communicate with your nearest NJE Field Representative in your area. If, after examination, he concurs that the unit is defective under the warranty conditions, he will provide written authorization for the return of the unit to the factory or the local field service center, whichever is nearest. N.J.E. Corporation will not assume any transportation charges on incoming equipment without the concurring written approval from its field representative.

PREFACE

The Instruction Manual which follows is a Standard NJE Catalog Model RVC-36-25-M Instruction Manual except that the specifications for Model CS36CR30 supersede those of the RVC-36-25-M in Section 1 and the necessary changes are made to the drawings in Section V.

Where discrepancies exist between the data relating to the CS36CR30 and the data relating to the RVC-36-25-M, the CS36CR30 data shall govern.

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DASH NO.	PART NO.	MODEL TYPE	ORDNANCE DRAWING	SPECIAL FINISH	CHASSIS SLIDES PROVIDED	SPECIAL NOTES	NJE SPEC.
01	82158	CS36CR30	7907346 Rev. D	102272-86	No	1	104389
02	83848	CS36CR30-D2	7907346-2 Rev. G	102272-66	Yes	2	112977

NOTES:

1. ORDNANCE DRAWING 7907346. REV. D, HAS BEEN ASSIGNED NJE DRAWING NUMBER 104390 FOR NJE INTERNAL USE ONLY.

2. ORDNANCE DRAWING 7907346 REV. G, HAS BEEN ASSIGNED NJE DRAWING NUMBER 112978 FOR NJE INTERNAL REFERENCE ONLY.

NJE CORPORATION
KENILWORTH, N. J.

SIZE | SCALE | CODE IDENT NO. 93390 | REV | DWG NO. 112976 | SHEET 2

SECTION 1

SPECIFICATIONS

1.1 GENERAL:

The RVC line of Silicon Controlled Rectifier Series Regulated Power Supplies is designed for use in applications where a well regulated source of DC power is required and where close regulation of the output voltage and output current is required. The specifications herein are tabulated (See Table 1-1) where ratings change from unit to unit or from Constant Voltage Mode to Constant Current Mode of operation. The specifications are generalized into paragraphs where ratings are common.

1.2 GENERAL ELECTRICAL SPECIFICATIONS:

1.2.1 Input: 105 to 125V, 55 to 65 cps, single phase. Input currents are specified in Table 1-1.

1.2.2 Output Voltage and Current: See Table 1-1.

1.2.3 Static Regulation:

1.2.3.1 Load: At constant input voltage, the regulation is less than the figure indicated in Table 1-1 for a load change from half load to full load and is less than the figure indicated in Table 1-1 for a load change from half load to no load.

1.2.3.2 Line: At constant load, the regulation is less than the figure indicated in Table 1-1 for a line change from 115 to 105 and less than figure indicated in Table 1-1 for a line change from 115 to 125V.

1.2.4 Ripple: 1 millivolt RMS, maximum.

1.2.5 Transient Response: For a ±10 volt prolonged step change in line voltage the output will remain in the regulated region. For a no load to full load or a full load to no load prolonged step change, the output voltage will return to within 20 millivolts of the regulated region in less than 50 microseconds.

1.2.6 Meters: Standard models do not include meters. Output can be monitored by means of the two front panel output jacks.

1.2.7 Polarity: The output may be "floated" up to 500V peak above ground. Either polarity may be grounded to chassis by means of terminals provided.

1.2.8 Duty: Continuous at ambient temperatures from 0° C to 50° C. Operation above 50° C is allowed provided the output current is derated linearly to zero at 80° C.

1.2.9 Remote Sensing: (For Constant Voltage Mode Only) Sensing terminals, separate from the Output terminals, provide sensing and load regulation against the voltage at the load rather than the voltage at the power supply output terminals. This eliminates the otherwise unavoidable load regulation due to the voltage drop in the wires connecting the supply to the load. This feature does not eliminate voltage excursions resulting from load transients through load line impedance.

1.2.10 Remote Programming: The output voltage may be controlled accurately from a remote point if desired, by varying the resistance across the REMOTE PROGRAM terminals. The sensitivity of this circuit is approximately 140 ohms per volt above the minimum voltage and within the voltage limits of Table 1-1.

1.2.11 Dualling: Two or more units may be operated in series to provide higher voltage output at rated current. Like units may be operated in parallel provided that the total current drawn is derated by 10%. All dual unit installations must meet the cooling requirements of Paragraph 1.3.2.

1.2.12 Termination: A barrier type terminal strip at the rear of the unit provides interface connection for input, output, remote sensing, remote programming and ground. Front panel binding posts for output termination in addition to the output terminals at the rear are provided.

1.2.13 Protection: Overload protection is provided by the mode of operation as discussed in Paragraph 1.2.15 below. Protective fuse will interrupt input power in the event of component failure.

1.2.14 Output Capacitor: The output capacitor is brought out to separate terminals at the rear of the unit. For normal operation, the factory set jumpers from the output capacitor to the respective output terminals should be left in place. Where improved transient response and dynamic characteristics are desired, the jumpers may be removed and an output capacitance connected directly at the remote load.

1.2.15 Mode of Operation: Constant current and constant voltage levels may be preset within the maximum rated voltage and current levels specified in Table 1-1. Referring to the graph of Figure 1-1, the intersection of the constant voltage and constant current operation lines, called the "Crossover Point", may be located anywhere within the output volt-ampere range of the unit. Regardless of the demands of the load, the output voltage and/or the output current will never exceed the limits preset by the output voltage and output current controls.

1.2.16 Resolution:

1.2.16.1 Output Adjust: Continuously variable coarse and vernier OUTPUT ADJUST potentiometers on concentric shafts provide a resolution of 18 millivolts.

1.2.16.2 Current Control: Continuously variable single turn potentiometer provides resolution per Table 1-1.

1.3 MECHANICAL SPECIFICATIONS:

1.3.1 Outline Drawing: Table 1-1 indicates which Outline Drawing is applicable to the unit in question.

1.3.2 Airflow: Units with panel height of 3-1/2" do not have blowers and depend on conduction and convection for cooling. Units of panel height 5-1/4" and greater have internal blowers and depend on forced air cooling in addition to the conduction and convection cooling. Air flow paths as indicated in the appropriate Outline Drawing must not be blocked. Where two or more units are rack-mounted one above the other or where adjacent equipment increases the ambient temperature above the limits specified in Paragraph 1.2.8 above, filler panels of at least

1-3/4" height should be installed above and below the power supplies in question.

1.3.3 Mounting: When installed in racks, it is recommended that support angles be provided so that the power supply weight is not supported entirely by the front panel mounting hardware.

1.3.4 Finish: Front Panel finished in dark grey enamel equivalent to FED STD 595 chip #26132. Panel marking is white. All other finishes are appropriate paint, plating or chemical film as required.

1.4 OPTIONAL FEATURES:

Table 1-2 indicates the specific optional features which are available on any given unit. The general description of these optional features follows:

1.4.1 Suffix (-50): Extension of the Input frequency range to 47-65 cps. This option requires that the Output current be derated by 1/3 of the maximum rating as specified in Table 1-1.

1.4.2 Suffix (-B): Addition of bench adapter.

1.4.3 Suffix (-P): Addition of three wire power cord and plug.

1.4.4 Suffix (-SF): Non-standard finish to front panel of unit.

1.4.4.1 Where specifying (-SF) option customer must provide NJE the following information:

Color to be used (preferrably FED STD 595 chip number).

Color to be used for marking.

Process to be used if other than NJE Standard finish process.

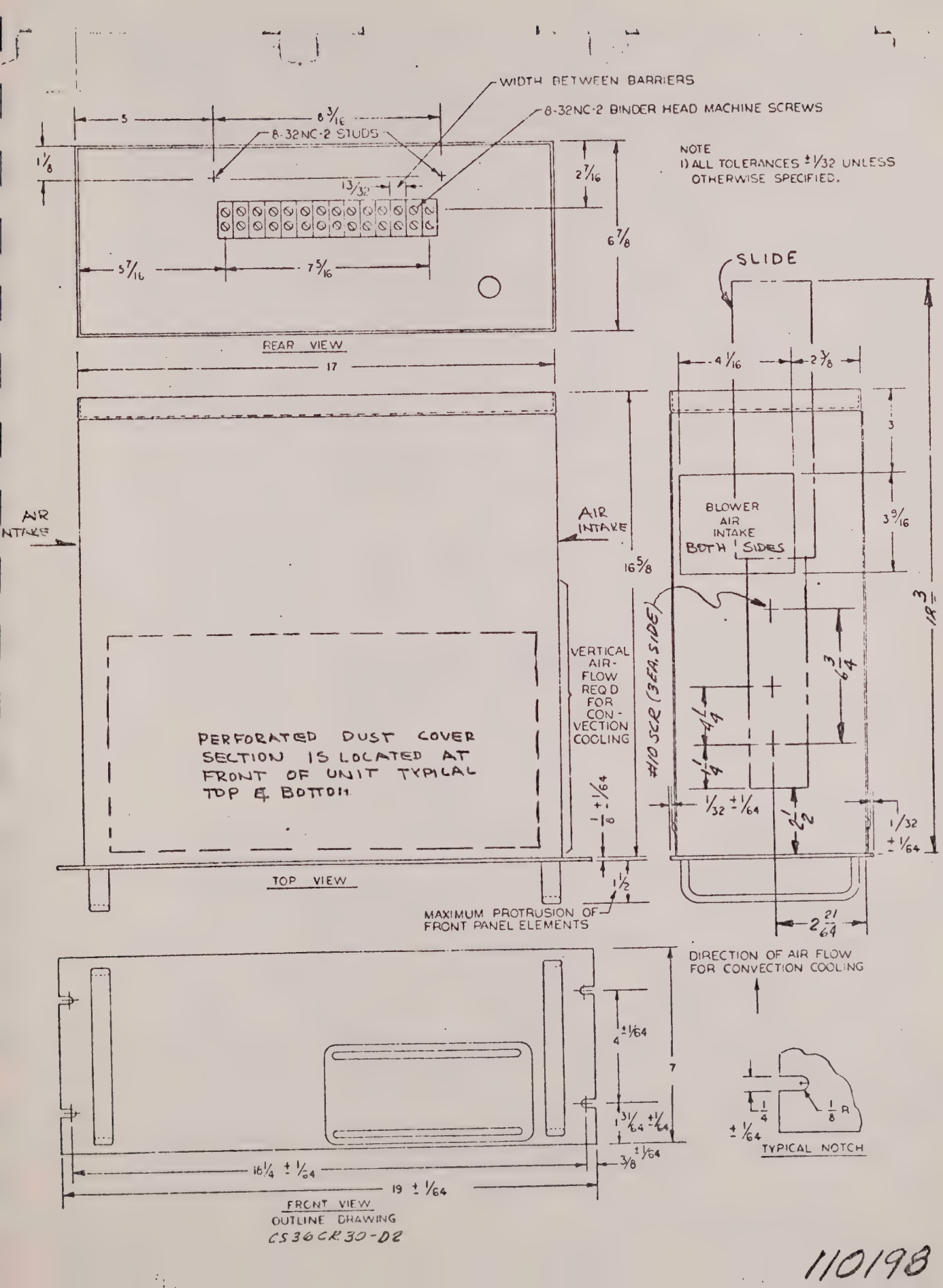
1.4.5 Suffix (-LV) and/or (-LC): Output adjust (-LV) or Current Control (-LC) potentiometer and knob replaced by a single turn screwdriver adjust potentiometer with shaftlock. (-LV) option changes Output Adjust resolution to 1%.

1.4.6 Suffix (-M): Addition of meters where standard unit is supplied without meters.

1.4.7 Suffix (-TT): Replacement of Standard Output Adjust Potentiometer by a ten-turn continuously variable potentiometer with a decade dial and lock, providing an improved resolution of 0.02%.

NOTE: Example of buildup of final model number for a RVC-35-5 with meters and bench adapter is as follows: RVC-35-5-M-B.

NOTE: NJE Corporation invites requests for quotations on special requirements which can be accomplished by deviations of standard catalogue units.

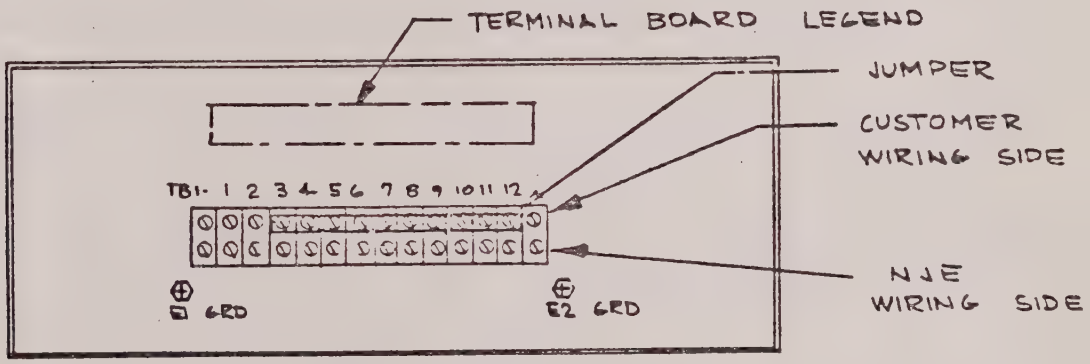

WIDTH BETWEEN BARRIERS
8-32NC-2 BINDER HEAD MACHINE SCREWS
8-32NC-2 STUDS
5
8 3/16
1 1/8
13/32
2 7/16
6 7/8
5 7/16
7 5/16
REAR VIEW
NOTE
1) ALL TOLERANCES ±1/32 UNLESS OTHERWISE SPECIFIED.
SLIDE
17
4 1/16
2 3/8
3
3 9/16
BLOWER AIR INTAKE BOTH SIDES
AIR INTAKE
AIR INTAKE
16 5/8
18 3/4
#10 SCR (3 EA. SIDE)
VERTICAL AIR-FLOW REQ'D FOR CONVECTION COOLING
PERFORATED DUST COVER SECTION IS LOCATED AT FRONT OF UNIT TYPICAL TOP & BOTTOM
1 ± 1/64
1/8
1/32 ± 1/64
1/2
1/32 ± 1/64
TOP VIEW
1/2
MAXIMUM PROTRUSION OF FRONT PANEL ELEMENTS
2 21/64
DIRECTION OF AIR FLOW FOR CONVECTION COOLING
4 ± 1/64
7
31/64 ± 1/64
3/8 ± 1/64
16 1/4 ± 1/64
19 ± 1/64
FRONT VIEW
OUTLINE DRAWING
CS36CR30-D2
1/4
1/8 R
± 1/64
TYPICAL NOTCH

110198

TB1 TERMINAL BOARD LEGEND				
TERM NO	SCREENED FUNCTION	RECOM'D WIRE SIZE	REMARKS	
1	AC	NO 12 AWG	HIGH SIDE OF AC INPUT	
2	AC	NO 12 AWG	RETURN SIDE OF AC INPUT	
3 4	REMOTE PROGRAM	NO 20 AWG TWSTD PR.	NORMALLY JUMPED TOGETHER	
5 6	DUALLING	NO 20 AWG SHIELDED	NORMALLY JUMPED TOGETHER	2
7	POS SENS	NO 20 AWG	NORMALLY JUMPED TO POS OUT	1
8	POS OUT	NO 10 AWG		
9	POS CAP	NO 10 AWG	NORMALLY JUMPED TO POS OUT	
10	NEG CAP	NO 10 AWG	NORMALLY JUMPED TO NEG OUT	
11	NEG OUT	NO 10 AWG		
12	NEG SENS	NO 20 AWG	NORMALLY JUMPED TO NEG OUT	1

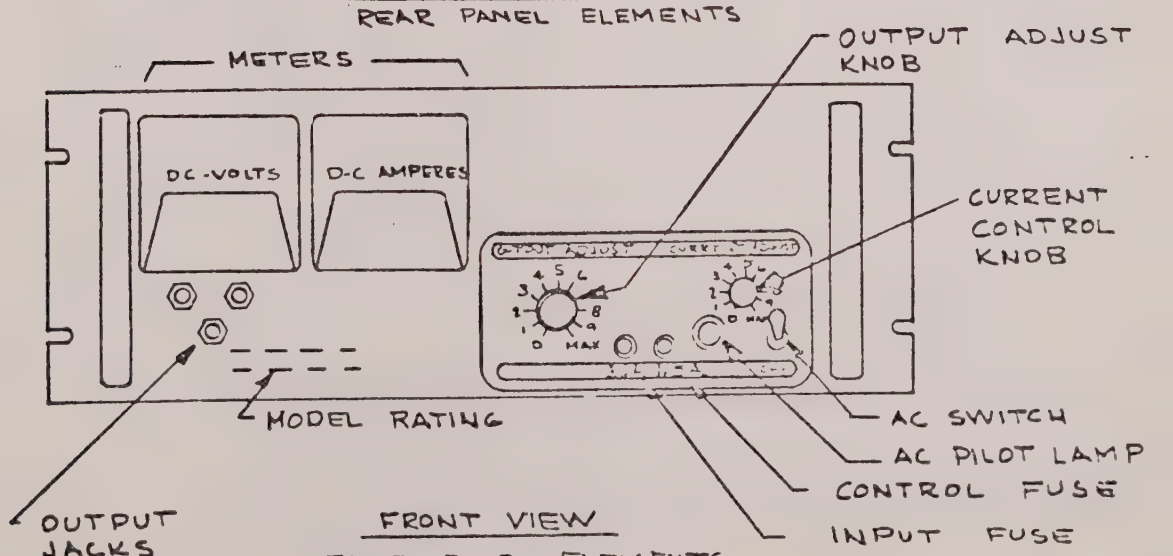
E1	GRD	NO 12 AWG	AC GROUND
E2	GRD	NO 10 AWG	DC GROUND

1 - TWISTED PAIR WHERE USED
2 - TERMINAL NO 5 IS DUALLING DRIVE POINT.



REAR VIEW

REAR PANEL ELEMENTS



FRONT VIEW

FRONT PANEL ELEMENTS

CS-36CR30

SECTION II

INSTALLATION AND OPERATION

2.1 UNPACKING: The power supply is shipped in a corrugated carton which is floated on sufficient insulation in a heavy-duty shipping carton. Aside from normal precaution against damage to the unit in opening the cartons and removing the unit, no special procedures are required. The carton should be opened immediately upon receipt and the contents inspected for shipping damage. The power supply was checked electrically and mechanically before it left the factory, and is warranted to be in perfect operating condition. This warranty does not cover possible damage incurred during shipment. Therefore, any evidence of mishandling, such as broken, deformed or missing parts, should be brought to the attention of the transportation company, and a claim should be entered. Remove top cover plate and inspect all components and wiring, both on the chassis panel, as well as the mechanical condition of the housing. The literature packed with the supply should be removed and held for reference in operating the equipment.

2.2 INSTALLATION: Refer to Table 1-1 which indicates which Outline Drawing is to be followed for the model in question. This Outline Drawing shows mounting dimensions, air flow requirements, interface wiring information and other data pertinent to proper installation. Careful observance of all the specification requirements in Section I is essential to a proper installation. READ THE SPECIFICATIONS CAREFULLY BEFORE PROCEEDING.

When the unit has been properly placed in position or mounted in its rack and secured in place by the panel screws, electrical connections should be made in accordance with the following step-by-step procedure. Wire sizes to be used and the terminal locations are specified on the appropriate Outline Drawing of Section 1-3. Terminal functions listed in the following instructions are clearly screened on the equipment itself, as well as being indicated on both the outline of Section 1-3 and the Schematic Diagram of Section V.

2.3 STANDARD SINGLE UNIT ELECTRICAL INSTALLATION:

2.3.1 Output Grounding: Connect either the positive (POS OUT) or negative (NEG OUT) DC output terminal of the supply (depending upon desired output polarity) directly to the chassis ground terminal (GRD) at the barrier strip on the rear of the chassis, and connect the ground terminal to the system ground.

NOTE: If it is necessary that the power supply circuit float above or below ground, it is recommended that the output terminal should be connected to the chassis ground terminal by a 0.1 microfarad 600 VDC capacitor in place of the direct connection. Use of this by-pass capacitor will improve the stability of the circuit in the ungrounded condition, and reduce the effect of external interference and hum. Refer to Polarity Specification in Section I for maximum limitation on floating voltage permitted.

2.3.2 Output Connection: Connect the positive and negative output terminals (POS OUT) and (NEG OUT), respectively to the corresponding terminals of the external load. Use heavier gauge wire than that specified if long distances to the load are involved.

2.3.3 Remote Sensing: All units are shipped from the factory with the REMOTE SENSING feature jumpered out on the inter-connection terminal board as follows: (POS SENS) connected to (POS OUT) and (NEG SENS) connected to (NEG OUT). With this connection, the regulation specifications are met ONLY at the output terminals of the supply. If it is desired to have accurate regulation at the remote load point, rather than at the output terminals, proceed as follows:

Connect the output terminals to the load per Paragraph 2.3.2 above. Remove the Jumpers from (POS SENS) to (POS OUT) and (NEG SENS) to (NEG OUT) respectively. Observing correct polarity, run a twisted pair of No. 20 AWG wire (or larger) from (POS SENS) to the positive load point and from (NEG SENS) to the negative load point.

WARNING: DO NOT OPERATE POWER SUPPLY WITHOUT THE SENSING LEADS CONNECTED EITHER REMOTELY OR LOCALLY. MOST CUSTOMER COMPLAINTS OF POOR OPERATION ARE DUE TO IMPROPER SENSING LEAD CONNECTION.

WHEN THE POINT OF REMOTE SENSING IS MORE THAN 10 FEET FROM THE POWER SUPPLY, OSCILLATIONS MAY DEVELOP. A POSSIBLE CURE IS TO CONNECT REMOTE CAPACITANCE AS DESCRIBED IN PARAGRAPH 2.3.4 AND AS CLOSE TO THE POINT OF SENSING AS IS PHYSICALLY POSSIBLE.

2.3.4 Output Capacitor Connections: This feature is not provided on all units. When included in the equipment, the terminals are listed as (POS CAP) and (NEG CAP) on the Outline Drawing. The power supply has been shipped from the factory with the appropriate filter capacitors connected to the appropriate output terminals at the interconnection terminal board. This arrangement is satisfactory for most applications. However, if better transient and dynamic characteristics are required, further improvement can be effected by using an independent capacitor mounted as close to the ultimate load as is practical.

The capacitor used should have the same voltage rating of the power supply output capacitance (see the Schematic Diagram for the rating of the capacitor connected to the Pos Cap and Neg Cap terminals) and at least the same capacitance rating should be used. Additional capacitors may be ordered by specifying the NJE Part Number of the output capacitor from the Spare Parts List of Section V.

Reconnections are made as follows: Remove the jumper connection provided between (Pos Out) and (Pos Cap) and between (Neg Out) and (Neg Cap). The load leads should be connected as in Paragraph 2.3.2 above. Connect the new capacitor directly at the load being careful to observe polarity. In order to make this connection effective, it will be necessary to utilize the Remote Sensing Connections described in Paragraph 2.3.3 above.

2.3.5 Remote Programming:

To utilize either the Remote Voltage Program or Remote Current Program when specified per Section I, remove jumper across the appropriate terminals and connect a resistor across the Remote Program terminals. If the resistor is to be located remotely from the power supply, a twisted pair of No. 20 AWG should be used. The resistance (R) of the remote program resistor may be calculated as follows:

2.3.5.1 Remote Voltage Program

$$R \ (\Omega/V) \ (V_o - V \text{ min}) \text{ ohms}$$

Where (R) is the desired resistance, (Ω/V) is the Remote Programming Sensitivity from Section I. (V_o) is the desired output voltage and (V min) is the minimum voltage allowed for the power supply as specified in Section I.

The VOLTAGE ADJUST potentiometers should be set to zero (extreme counter clockwise) when this connection is used.

2.3.5.2 Remote Current Program (where specified in Section I).

$R \quad (\Omega/I)\ (I_o - I\ min)$ ohms

Where (R) is the desired resistance, (Ω/I) is the Remote Programming Sensitivity from Section I. (I_o) is the desired output current and (I min) is the minimum current.

The CURRENT ADJUST potentiometers should be set to zero (extreme counter clockwise) when this connection is used.

WARNING: DO NOT OPERATE THE POWER SUPPLY WITH EITHER "REMOTE PROGRAM" TERMINAL OPEN CIRCUITED.

2.3.6 Input Connection:

2.3.6.1 For those units supplied without three wire line cord and plug, refer to the applicable Outline Drawing in Table 1-1. Connect the proper wire size specified to the two (2) AC terminals observing that the "high" and "return" leads must be wired to the respective terminals. The system ground is connected to the GRD terminal associated with the AC input terminals.

2.3.6.2 Three-phase Units: All units which are specified in Table 1-1 as "208 volts, three-phase", are intended to be used with a four wire system with the neutral connected. The Outline Drawing indicated in Table 1-1 indicates the correct wire sizes to be used in wiring to the Phase A, Phase B, Phase C and Neutral terminals. In addition, the system ground must be connected to the GRD terminal associated with the AC input terminals. For those units where Table 1-1 specifies input of 460 volts three-phase or 220 volts three-phase three-wire, the system is a three wire system with no neutral. The connection is similar to that of the four wire system except that no neutral load is required.

2.3.7 Constant Current Connection:

Where specified in Section 1, some NJE Power Supplies may be converted to Constant Current Regulated supplies. Figure 2-1 provides information for making this reconnection. Since there are numerous possibilities and parameters which must be considered, the information provided must of necessity be limited. For special applications, consult the factory Application Engineering Department.

On those units equipped with variable current limiting overload protection (See Section 1), and where regulation requirements are restricted, Constant Current applications may be achieved directly without resorting to the more refined connection of Figure 2-1. This method of operation is described in Section 2-5.

2.4 DUALLING:

2.4.1 Cooling of Dual Unit Installation:

Where the dual units are to be rack mounted one directly above the other, the filler panels referred to in Air Flow specification per Paragraph 1.3 must be used. These panels may be ordered from NJE Corporation if the same finish is desired. For standard finish, 1-3/4" by 19" filler panels, order NJE Part No. 22164.

2.4.2 Series Connection:

Those NJE Power Supplies which may be connected in series, as indicated by the Dualling specification in Section 1, can be so connected using Figure 2-2A. If "S" option is required, the unit should be ordered specifying the "S" option. Where field connection is required, reverse voltage protection diodes must be installed to protect against reverse voltage during a short circuit on the series connected supplies.

These diodes should have a Forward Average Current rating equal to or greater than the output current rating of the supply and a Peak Inverse Voltage rating greater than the highest operating voltage of the application. The diodes must be connected in the nonconducting direction across the power supply output terminals. The series connection is quite straight forward and is essentially the same as connecting two batteries in series. Each supply is independently controlled and delivers an output voltage within its own capability. The total output voltage, is of course, the sum of that of the two supplies.

Connection of the series option, including the location of the reverse voltage protection diodes, is clearly shown in Figure 2-2A. The connection of the sensing leads is for the remote sensing mode of operation. If precise regulation at the load is not required, the sensing leads may be left jumpered at the respective output terminals as in Paragraph 2.3.3.

2.4.3 Parallel Connection:

Those NJE Power Supplies which may be connected in parallel, as indicated by the Dualling Specifications in Section 1, can be connected in parallel using Figure 2-2B. The total paralleled current must be derated by 10% from the individual current rating as the two supplies cannot be made to divide the load exactly.

5 OPERATION:

2.5.1 The following check list should be followed before making the unit operational:

2.5.1.1 AC power switch in the off position.

2.5.1.2 VOLTAGE ADJUST potentiometer in the extreme counterclockwise position.

2.5.1.3 CURRENT CONTROL$^{\Delta}$ potentiometer (where provided) in the extreme clockwise position.

2.5.1.4 Input wiring made per Paragraph 2.3.6.

$^{\Delta}$Specified as CURRENT ADJUST on some models.

2.5.1.5 Output Grounding wired per Paragraph 2.3.1.

2.5.1.6 Output wiring made per Paragraph 2.3.2.

2.5.1.7 Remote Sensing wiring made per Paragraph 2.3.3.

2.5.1.8 Output Capacitor wiring (where provided) made per Paragraph 2.3.4.

2.5.1.9 Remote Programming wiring made per Paragraph 2.3.5.

2.5.1.10 Constant Current wiring (where provided) made per Paragraph 2.3.7.

2.5.1.11 Dualling connection (where desired) made per Paragraph 2.4.

2.5.2 Step-by-step operation based on the location of controls as indicated on the outline drawing specified in Table 1-1:

2.5.2.1 Energize the AC line.

2.5.2.2 Operate the AC power switch to the ON position. The pilot lamp should light.

2.5.2.3 While monitoring both output voltage and current, slowly rotate the VOLTAGE ADJUST potentiometer clockwise until the desired voltage level is reached.

2.5.2.3.1 If the desired voltage and/or current level (within the ratings of the unit) cannot be reached, de-energize the AC line and re-check all connections per Paragraph 2.5.1 above. If still unable to achieve the desired levels, refer to the Troubleshooting Section at the rear of the manual.

2.2.4 CURRENT CONTROL (where provided) may be set to the desired level as follows:

2.5.2.4.1 Method #1: While monitoring the load current, apply a short circuit across the load and rotate the CURRENT CONTROL potentiometer counter-clockwise, until the desired current level is reached.

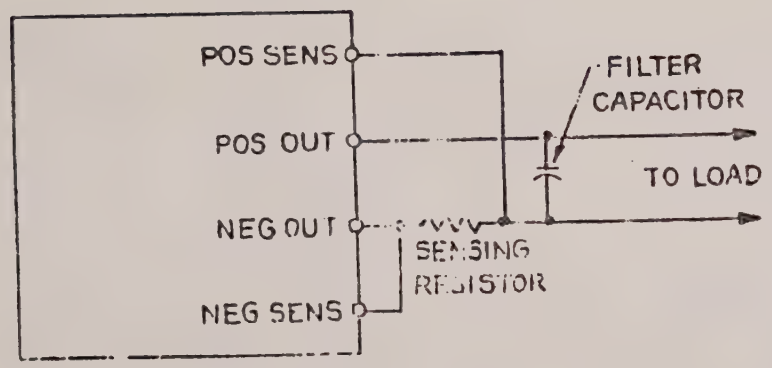
2.5.2.4.2 Method #2: While monitoring the load voltage and current, adjust the load so that the desired levels are reached. Rotate the CURRENT ADJUST potentiometer(s) slowly counter-clockwise until the current level begins to fall off.

Where specified in Section 1, some units are provided with MODE lamps. When the above step is performed on these units, the voltage MODE lamp should extinguish and the current MODE lamp should light. A slight clockwise adjustment of the CURRENT CONTROL potentiometer will then set the current limiting just above the operating level. The VOLTAGE MODE lamp should now light and the CURRENT MODE lamp should extinguish.

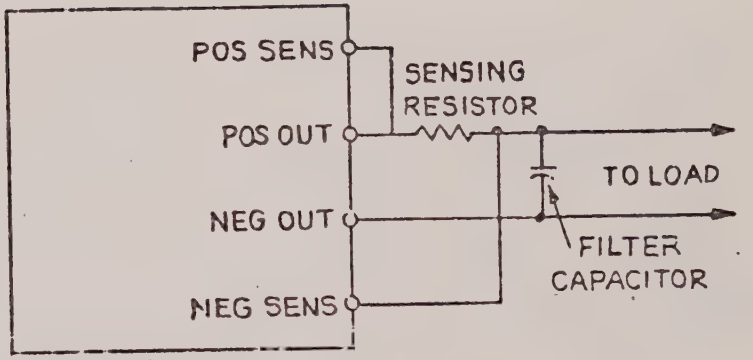
2.5.2.4.3 Method #3: Leaving the CURRENT CONTROL at the extreme clockwise position sets the current limiting action at approximately 110% of the maximum current rating of the supply.

NOTE 1: The current limiting feature is essentially a constant current device. As the load resistance is reduced toward an eventual short circuit condition, the load current will be limited to the present CURRENT CONTROL setting, and it will hold at this value as the output voltage falls toward zero. The current regulation is better than 5% as the load resistance varies to cause a full swing of output voltage and is proportionally better for smaller load resistance changes.

NOTE 2: For the RVC, RB and SVC Lines which are provided with both voltage and current regulation with automatic crossover circuitry, the current limiting characteristic described above is highly regulated. Actual current regulation parameters are in accordance with the specifications noted in Section 1.



ALL UNITS EXCEPT TC LINE



TC LINE ONLY

PROCEDURE

1. SENSING RESISTOR SHOULD BE SELECTED TO PRODUCE APPROXIMATELY 1 VOLT DROP AT MAXIMUM DESIRED CONSTANT CURRENT. RESISTOR WATTAGE SHOULD BE AT LEAST FOUR TIMES MAXIMUM DISSIPATION FOR CURRENT STABILITY. SEE NOTE 4.
2. FILTER CAPACITOR SHOULD BE 6-10 MICROFARADS, OIL OR TANTALYTIC, WITH VOLTAGE RATING GREATER THAN MAXIMUM DESIRED OUTPUT VOLTAGE.

NOTE 1: SEE OUTLINE DRAWING, SECTION I, FOR TERMINAL CONNECTIONS AND WIRE SIZES.

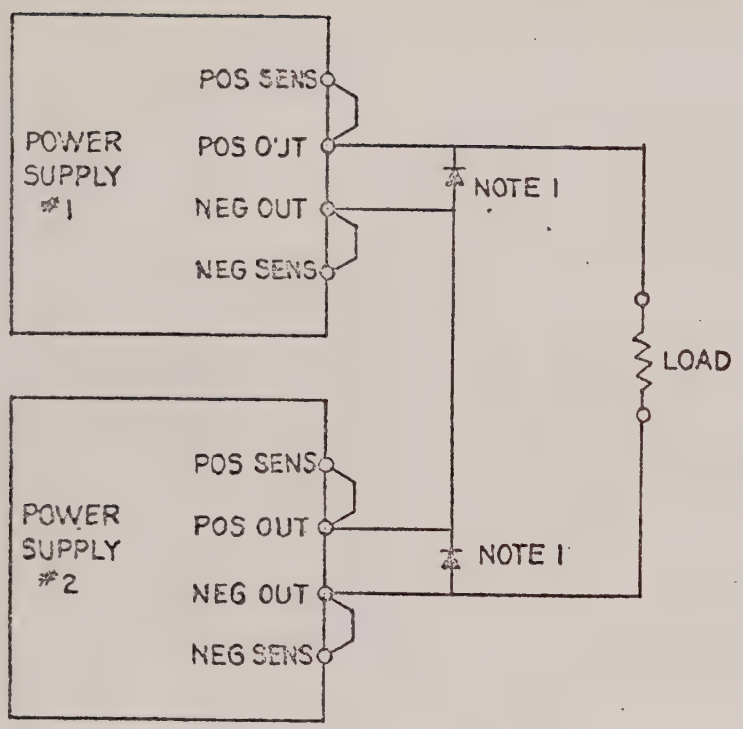
NOTE 2: ON TC UNITS, AN INTERNAL JUMPER BETWEEN TERMINALS 6 AND 11 ON PRINTED CIRCUIT BOARD A2 (S.P.C.) MUST BE ADDED FOR CONSTANT CURRENT OPERATION.

NOTE 3: A POTENTIOMETER APPROXIMATELY 10% OF THE RESISTANCE OF THE OUTPUT ADJUST POTENTIOMETER SHOULD BE INSERTED IN THE PROGRAMMING TERMINALS. THE OUTPUT ADJUST SHOULD BE SET TO ITS MINIMUM POSITION. THE NEW POTENTIOMETER WILL THEN PROVIDE CURRENT CONTROL OVER THE DESIRED RANGE. IF DESIRED, THE OUTPUT ADJUST ITSELF MAY BE USED FOR CURRENT CONTROL, BUT ONLY THE LOWEST PORTION OF THE POTENTIOMETER IS USED. IF AVAILABLE ON THE SUPPLY, THE FINE CONTROL CAN PROVIDE ADEQUATE RESOLUTION.

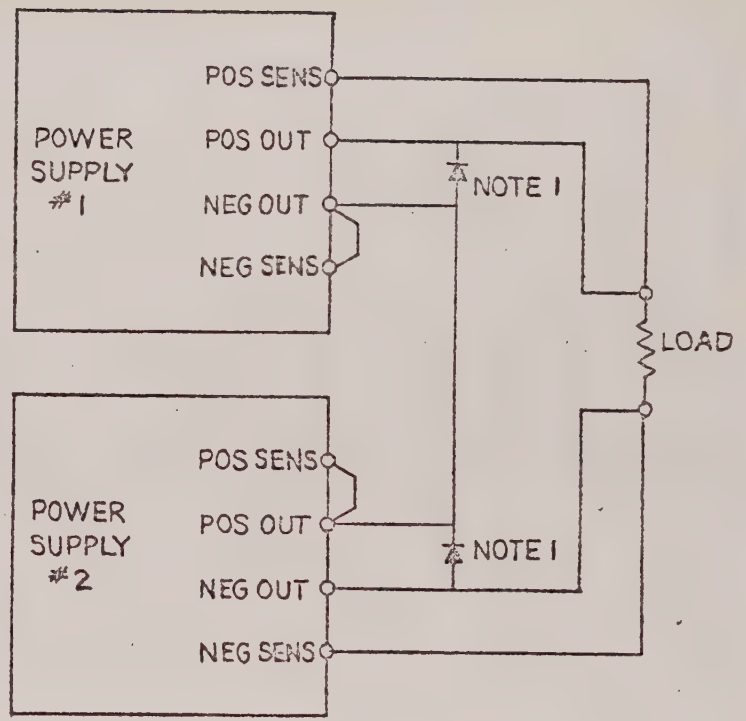
NOTE 4: LOW TEMPERATURE COEFFICIENT RESISTORS WILL IMPROVE STABILITY.

CONSTANT CURRENT CONNECTION

FIG. 2-1



LOCAL SENSING



REMOTE SENSING

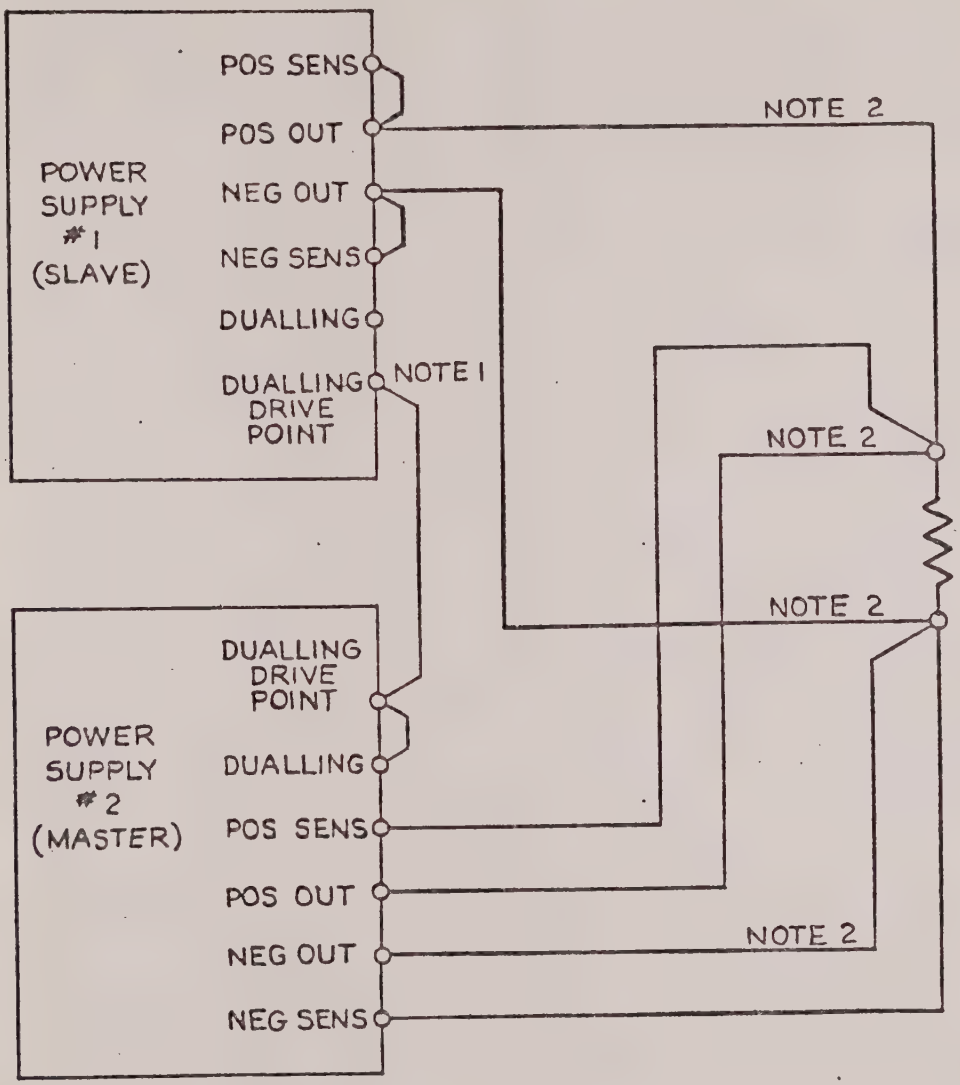
NOTE 1: REVERSE VOLTAGE DIODE, AS REQ'D. SEE PARA. 2.4.2
SEE OUTLINE DRAWING, SECTION I, FOR TERMINAL CONNECTIONS AND WIRE SIZES.

SERIES CONNECTION

FIG. 2-2A

E01573

103949



NOTE 1: JUMPER REMOVED FROM DUALLING TERMINALS ON "SLAVE" UNIT. INTERCONNECT DUALLING DRIVE POINTS BETWEEN "MASTER" AND "SLAVE" UNIT. SEE OUTLINE DRAWING, SECTION I, FOR TERMINAL CONNECTION AND WIRE SIZES, INCLUDING DRIVE POINT.

NOTE 2: LOAD LINE RESISTANCES SHOULD BE BALANCED CLOSELY FOR OPTIMUM OPERATION.

PARALLEL CONNECTION

FIG. 2-2B

SECTION III

THEORY OF OPERATION

3.1. GENERAL: A simplified block diagram illustrating the basic elements of the circuit and the signal flow is shown in Figure 3-1. The AC line voltage is transformed to adequate values to supply the rectifiers and controlled rectifiers through the main transformer. The firing circuit and transistor amplifier voltages are obtained from auxiliary transformer windings and associated AC to DC rectifier and filter systems. The average value of the output from the power rectifier circuitry is filtered by a capacitor input filter. The control of the average voltage across the capacitor input filter is accomplished by control of the trigger angles of the SCRs and will be discussed later. In the constant voltage mode, the output voltage furnished to the load by the series regulator is monitored by a feedback amplifier, which compares this voltage with a stabilized reference voltage, and amplifier the difference between the two voltages. The output of the amplifiers is used to control the series regulator in such a way that it counteracts any change in the DC output voltage, thereby furnishing an essentially constant voltage to the external load. In the constant current mode, the output current furnished to the load by the series regulator is monitored by a second feedback amplifier which compares the voltage drop across a series resistor with a stabilized reference voltage and amplifies the difference between the two voltages. The output of this amplifier follows the same control path as the constant voltage mode and is used to control the series regulator in such a way that it counteracts any change in the DC output current thereby furnishing an essentially constant current to the external load. The controlled rectifier is basically a device which controls the magnitude of average DC voltage at the capacitor input filter in such a way as to maintain the storage voltage across the series regulator within its dissipation capabilities.

3.2 DETAILED CIRCUIT DESCRIPTION: Circuit references in the following material apply to the schematic diagram at the back of the manual. This diagram shows electrical relationships, and is laid out in an arrangement approximately the same as that of the Block Diagram, Figure 3-1.

3.3 The power supply is energized by connecting 115 volts (nominal) 60 cycles, single phase, to the input terminals and closing switch (S1), attested by the lighting of pilot lamp (DS1) and starting of fan (B1).

3-4 The power transformer winding (T1) converts the input line voltage to an appropriate value, which is rectified to a pulsating DC output voltage by rectifier assemblies (A4) and (A5). Each assembly consists of an SCR (CR1) and a standard rectifier (CR2) to form a full wave single phase bridge configuration. The DC voltage is then filtered by capacitor (C1) and applied through regulating transistor assemblies (A2) and (A3) to the external load. Each assembly consists of transistors (Q1, Q2,Q3 and Q4) in parallel, and the two assemblies are connected in parallel. Some models may have fewer or more transistors in the individual assembly. See the schematic diagram for the exact number of components. Capacitor (C2) provides additional filtering of the output, and reduces the internal impedance of the supply for medium frequency load variations. Additional output capacitance is provided on some models for further high frequency response improvement and spike suppression.

3.5 The output voltage on the transformer (Aux winding) is rectified by diodes (A1 CR8 and A1 CR9) and (A1 CR10 and A1 CR11) and smoothed by capacitor input filters (C6 and C7) on Model RVC 36-15 and (C5 and C6) on Model RVC 36-25 to provide positive and negative operating potentials for the feedback amplifier. The breakdown diode (A1 CR14), in conjunction with its load resistor (R30), provides regulated -18 VDC. Breakdown diode (A1CR12), in conjunction with its load resistor (R28), provides regulated -5.6 VDC. These breakdown diodes function in a manner analogous to that of a gaseous voltage regulator tube, providing a relatively stable output voltage across their terminals despite variations in the conducted current. These bias voltages also supply the controlled rectifier trigger circuit. The function of this circuit will be described later.

3.6 Negative amplifier bias voltage of approximately -15 volts is obtained through a series regulator (A1 Q7) and filter capacitor (A1 C7). The series regulator is driven by a single stage differential pair consisting of (A1 Q8) and (A1 Q9). The differential action is achieved by comparing the divider voltage derived from resistors (A1 R34) and (A1 R35) against the reference voltage of (A1 CR21) which is derived directly from -15 Volt bias in conjunction with diode load resistor (A1R56). Individual main reference voltages of -6.2 VDC for both the voltage and current regulating circuitry are also dervied from the -15 VDC bias voltage. These consist of breakdown diode (A1 CR19) in conjunction with load resistor (A1R39) for voltage reference and breakdown diode (A1 CR20) in conjunction with load resistor (A1R55) for current reference.

3.7 Positive amplifier bias voltage of approximately + 15 volts is obtained through a shunt regulator (A1 Q5), limiting resistor (A1 R26), and filter capacitor (A1 C8). The shunt regulator is driven by a single stage of gain (A1 Q6). The output voltage of this bias source is estabilished by the divider consisting of resistors (A1R13) and (A1 R33). The feedback action forces the positive bias voltage to be equal to the negative bias voltage, since the divider resistors are equal and are connected between the two sources.

3.8 The main feedback amplifier loop which is common to both voltage and current modes consists of three stages of amplification; the first two of these are balanced differential amplifiers, assuring minimum sensitivity to fluctuations in ambient temperature or operating voltages. The input signal for the amplifier is derived from either a voltage sensing divider connected across the output of the supply or the current sensing pre-amplifier. Diodes (A1 CR16 and A1 CR17) are connected at the base of (A1 Q15) to provide protection for the transistor differential amplifier during surges arising from transient load conditions.

3.9 The output voltage divider consists of fixed resistor (A1 R37) and Voltage Range Adjust adjustable resistor (A1R38) in the amplifier circuit board, and VOLTAGE ADJUST dual potentiometer (R4) on the front panel. The positive end of this divider is connected to the positive sensing terminal and the resistance setting of variable resistor (R4) determines the operating value of the DC output voltage of the supply in a manner which will be explained below.

The variable resistor (R4) is a dual potentiometer connected concentrically to the VOLTAGE ADJUST COARSE-FINE knob on the front panel. (Some models use a 10-turn helipot element).

3.10 The output current sensing voltage is developed across power resistor (R3) in series with the negative output terminal of the supply. The output current signal is fed to the current pre-amplifier balanced input stage (A1 Q16) and (A1 Q17) by means of the divider consisting of fixed resistor (A1 R41) and Current Range Adjust adjustable resistor (A1 R40) in the amplifier circuit board, and CURRENT CONTROL potentiometer (R5) on the front panel. The resistance setting of variable resistor (R5) determines the value of the DC output current of the supply in a manner which will be explained below.

* (A7R1) in some models.

3.11 As described in Paragraph 3.6 above, diode (A1CR19) is a highly stable potential of -6.2 VDC for use as comparison voltage by the input stage (A1 Q14 and A1 Q15) of the feedback amplifier loop. One end of the reference is directly connected to the negative sensing terminal. When the output voltage of the power supply (measured at the load) is precisely at its selected nominal value, the voltage at the base of transistor (A1 Q15) is at the same level as the base of transistor (A1 Q14) and the input stage is in balance. Under this condition, any tendency of the load voltage to vary in either direction will unbalance the amplifier, resulting in corrective action which compensates for the change, and holds the voltage at its established value, as explained below. In an analogous manner, diode (A1CR20) provides a highly stable potential of -6.2 VDC for use as a comparison voltage by the input stage (A1Q16) and A1 Q17) of the current regulating feedback loop. When the output current is at its selected nominal value, the voltage at the base of transistor (A1 Q17) is at the same level as the base of transistor (A1 Q16) and the current regulator input stage is in balance. Any tendency of the load current to vary will unbalance the amplifier, resulting in corrective action which compensates for the change, and holds the current at its established value, as explained below.

3.12 Transistor (A1 Q14) and A1 Q15) are NPN type units, operated in common emitter mode and connected as a balanced differential amplifier. Their outputs, taken across load resistors (A1 R18 and A1 R19), are direct-coupled to the bases of the succeeding differantial amplifier stage (A1 Q12 and A1 Q13) which consists of two PNP transistors operated in common-emitter mode. The output of transistor (A1 Q12), from its load resistor (A1 R32) drives the base of the single ended emitter follower stage (A1 Q11). The output of the amplifier is tied directly to the base of the driver transistor (A1 Q21).

3.13 Current and voltage regulation of the DC output is performed by a double regulating system. A transistor series regulator consisting of power transistor assemblies (A2) and (A3) operating in parallel, provides high-speed regulating action to correct for ripple and transient variations both at its input (across C1) and at the output of the supply. The amplifier loop provides correction signals to the series regulator from signals derived from the output voltage and current. Silicon controlled rectifiers (A4 CR1) and (A5 CR1) which are driven by the firing current are designed to regulate the "storage" voltage across the series regulator. The circuit is such that regardless of the output load requirement, the power dissipation of the series transistor regulator is maintained within its rating.

3.14 The silicon controlled rectifier trigger circuitry consists of (A1 Q1), (A1Q2), (A1 Q3), (A1 Q4) and associated components. The circuit adjusts the storage voltage of the pass transistor by controlling the average value of the voltage across (C1). This is accomplished in a manner analogous to thyratron circuitry in which the rectifiers are "fired", and thereby begin conduction, at some point later than the start of the half-wave cycle. Depending on whether the firing point or phase angle of firing is advanced toward the start of the cycle, or retarded away from the start of the cycle, the average voltage across (C1) will be increased or decreased. The circuit is designed to automatically maintain relatively constant voltage across the pass transistor, at a level at which the total dissipation is limited to safe value. Thus, the phase angle of firing is automatically adjusted, by means of the circuitry to be described below, to hold the pass transistor storage voltage relatively constant in spite of line voltage or load variations, or of output voltage and/or current adjustments. The trigger circuitry consists of essentially three sections, the charging circuit, the discharging circuit, and the firing circuit. Each is discussed separately.

The charging circuitry consists of diodes (A1 CR1), (A1 CR2), (A1 CR3), transistor (A1 Q1), capacitor (A1 C1), and resistor (A1 R1). It can be seen that diode (A1 CR3) is unusual as far as a standard full-wave center-tapped rectifying circuit is concerned. Its function is to decouple the junction point of (A1 CR1) and (A1 CR2) from the bias voltage output capacitor (A1 C2). Thus, the junction point of the three diodes follows the transformer aux. winding voltage rather than remaining at the capacitor potential, and the point effectively moves along the half-sine curve of a typical full wave rectifier configuration. It follows, therefore, that capacitor (A1 C1) is charged through (A1 Q1) and (A1 R1), to the transformer center tap zero-level (the diodes A1 CR1, A1 CR2 conduct on the negative half-cycle) once each half-cycle as the transformer voltage approaches its zero level. The base of transistor (A1Q1) is held at a potential somewhat below the center-tap of the auxiliary transformer winding by means of the divider action of resistors (A1R3) and (A1R4 and R5). The emitter of this transistor is changing with the transformer voltage, and once each half cycle, as the transformer voltage approaches the center-tap potential, the transistor is effectively "turned'on", and (A1 C1) is quickly charged.

Discharge of (A1 C1) is effected linearly through (A1 Q2). The storage adjust divider resistors (A1R22 and A1R24) is set at some point which fixes the base voltage of (A1 Q2). This establishes the emitter voltage level, since the transistor is connected as an emitter follower. Thus the voltage across (A1 R27) is held constant requiring a constant current discharge of (A1 C1) to flow through transistor (A1 Q2). It can be seen therefore that the waveshape on (A1 C1) is essentially a saw-tooth, with its peak voltage at the transformer center-tap zero level at the begining of each half-cycle, and falling off linearly for the duration of a half-cycle.

The firing circuit operates as follows: The base of transistor (A1 Q3) is set at a potential level dependent on the divider resistors (A1 R3 and R4), and (A1R5). The potential of this point is several volts below the zero level of the firing circuit given by the transformer auxiliary winding center-tap. (A1 Q4) is emitter-follower coupled to (A1 Q3). Thus, when the base of (A1 Q4), which is connected to the saw-tooth waveshape potential of (A1 C1), falls to the potential of the base of (A1Q3), both (A1 Q3) and (A1Q4) are "turned on". This in turn, fires the SCR (A4 CR1) through resistor (A1 R8) and (A5 CR1) through (A1 R7). Each SCR works alternately once each half cycle in synchronism with the line voltage. The diodes (A1 CR5) and (A1 CR6) clamp the SCR gates to the anode potential.

Storage voltage control of the series regulator assemblies (A2) and (A3) is achieved in the following manner. Suppose, for example, that the storage voltage tends to increase. This might occur under conditions of increased input line voltage, decreased load, or decreased output voltage. When this occurs, the potential of the collectors of the series transistors falls with respect to the zero level. The base and consequently the emitter of (A1 Q2) is correspondingly lower thereby reducing the voltage across (A1R27) and reducing the discharge current of (A1 C1). Thus, the discharge of (A1 C1) requires a longer time and consequently the turn-on of (A1 Q3) and (A1 Q4) occurs later in the half-cycle. This in turn causes a shorter firing period for the SCR's with a reduced average voltage at (C1). It is thus seen that when the storage voltage increases, a compensating action occurs which tends to restore the storage voltage to its orignial level. It is further recognized, that the silicon controlled rectifier's output tends to "track" the output voltage, and in this manner maintains the series regulator dissipation within fixed limits. Note that in the above paragraph the term "Storage Voltage " is used to denote the voltage across the series regulator transistor.

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3.15 The regulating principle of the series regulator feedback loop is to maintain balance at the base of transistor (A1 Q14 and A1 Q15). These bases will maintain balance within a small voltage which is the error voltage due to feedback loop gain level. Due to the high gain of the system, the error voltage will be small, and at most is equal to the maximum allowable error of the equipment.

The sequence of operation begins by adjustment of variable resistor (R4) or variable resistor (R5). Either change will unbalance the base of transistor (A1 Q15) with respect to transistor (A1 Q14) base. The system will adjust itself up or down until the voltage levels at both bases are equal. One such action will be described. Other distrubances cause the circuit to react in a similar manner.

If we wish to raise the output voltage, then the value of VOLTAGE ADJUST (R4) is increased. This increase decreases the voltage at the base of (A1 Q15). The error is amplified through the system and a signal is applied to the base of the series regulator transistor assemblies (A2) and (A3) in such a manner as to decrease its storage voltage. The controlled rectifiers at the same time raise the average level across capacitor (C1). The sensitivity and speed of response of the corrective feedback loop is such that the above-described action occurs almost instantaneously and the actual excursion of the load voltage or current is held to a very small value. The circuit is a true proportional regulator and must allow a small but finite "error" to exist between the required and actual regulated voltage or current, so that this error, however small, can generate the corrective signal. By proper circuit design, however, the error is held to a value which remains within the specified regulation allowance of the power supply.

When the variable resistor (R4) is readjusted to produce a different value of output voltage, the circuit makes a correction similar to that described above. Altering the resistance in the sensing voltage divider unbalances the input stage of the feedback amplifier, which then causes the circuit to produce a new value of voltage such that the drop across the resistors again equals the drop across breakdown diode (A1 CR19). Reducing the value of the variable resistor (R4), for example, momentarily increases the drop across resistors (A1 R37) and A1 R38). However, this unbalanced condition at the amplifier input causes the DC output voltage to decrease until the drop across resistor (A1 R37' and A1 R38) again equals the drop across breakdown diode (A1 CR19) and the circuit stabilizes at this new operating point, establishing a lower value of DC output voltage.

3.16 Variable resistor (A1 R38) in the amplifier is provided to permit compensation for manufacturing tolerances in breakdown diode (A1 CR19) its load resistor (A1 R39) and voltage feedback resistors (R4) and (A1 R37).

This resistor is adjusted for proper range of controls at the factory (and locked). If any of these components are replaced, a readjustment of (A1 R38) may be necessary. See Maintenance Section IV for the proper procedure for this readjustment.

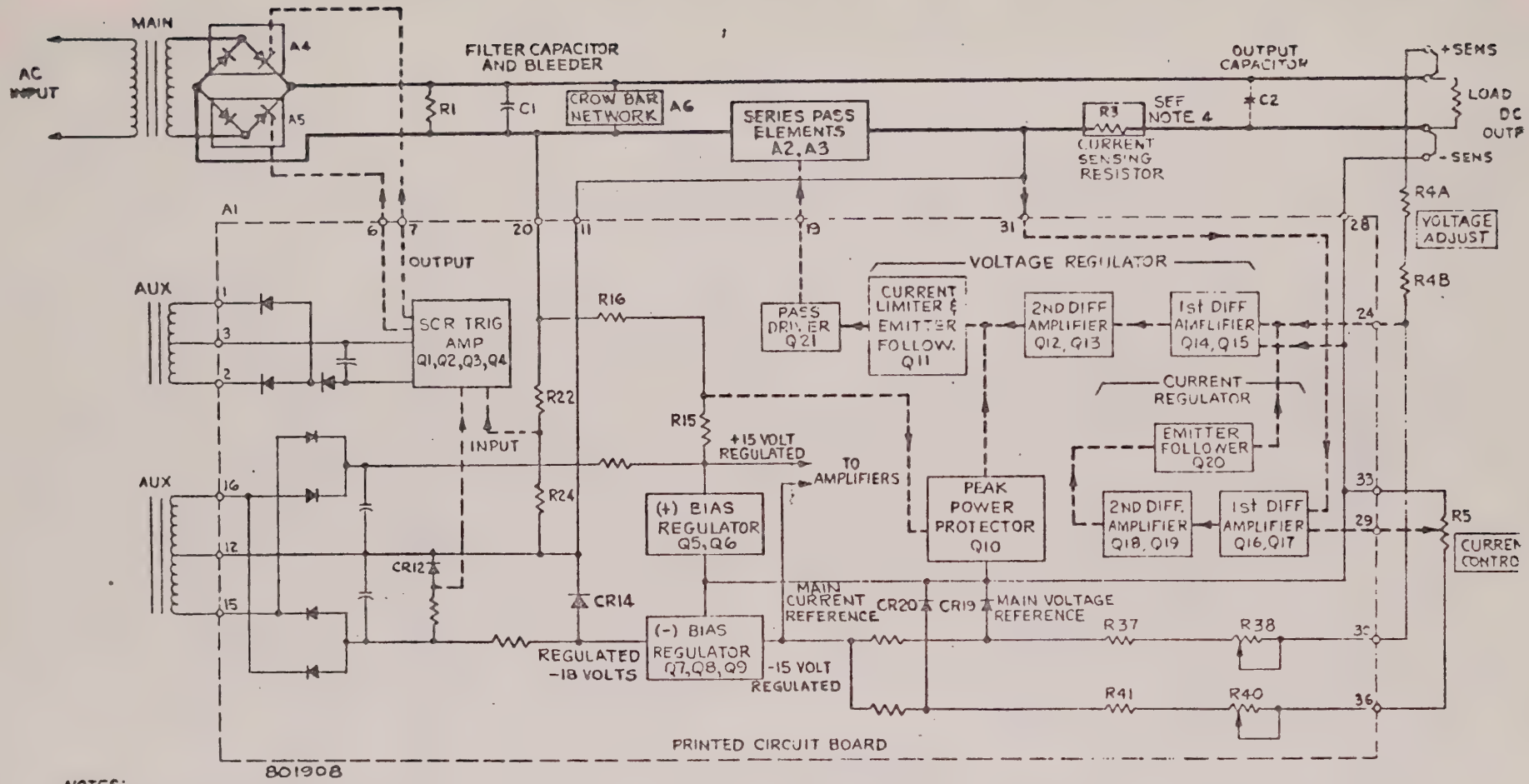
3.17 The operation of the current regulator pre-amplifier is accomplished by means of the following circuitry. Voltage at the base of transistor (A1 Q16) is established by the setting of CURRENT CONTROL potentiometer (R5). The voltage at the base of transistor (A1 Q17), the other half of the current regulation differential pair, is established by the voltage drop across current sensing resistor (R3). As load current increases to the value selected by the CURRENT CONTROL setting, the base voltage at (A1 Q17) continues to approach the voltage at (A1 Q16). When the load current reaches the value of the Current Control setting, the bases will be exactly in balance, and the next stage of the pre-amplifier (A1 Q18 and A1 Q19) is effectively "turned on". The final stage of the pre-amplifier, (Q20), is simultaneously "turned on". At this condition, diode (A1 CR18) conducts and the base of (A1 Q15) is clamped, thus overriding the voltage amplifier control. The action is quite sharp once conduction begins. Prior to conduction, the diode (A1 CR18) effectively decouples the current regulating pre-amplifier from the main amplifier. The circuitry described in this paragraph is often referred to as "Automatic Cross-over". Because of the decoupling circuit property of diode (A1 CR18) either the voltage amplifier is operating, or the current pre-amplifier is operating, but not both. Thus, in the region in which load current magnitude is lower than that of the Current Control setting, the diode decouples the current regulator. The power supply is in the voltage regulating mode, and the load current adjusts itself to the dictates of the load circuitry. In the region in which load current magnitude has achieved a value equal to the Current Control setting, the diode conducts and overrides the voltage regulator. The power supply is in the current regulating mode, and the output voltage adjusts itself to the dictates of the load circuitry.

3.18 Variable resistor (A1 R40) in the amplifier is provided to permit compensation for manufacturing tolerances in breakdown diode (A1 CR20), the current sensing resistor (R3),* and the CURRENT CONtrol components (R5), (A1 R41). If any of these components are replaced, a readjustment of (A1 R40) may be necessary. See Maintenance Section IV for proper procedure for this readjustment.

* (A7R1) in some models.

3.19 PEAK POWER PROTECTOR: The circuitry of (A1 Q10), (A1 R15), (A1R23), (A1R36) is provided to protect the series regulators (A2 and (A3) from over dissipation during short circuit when the storage voltage across the series regulators may attain a very high value until the silicon controlled rectifier is able to decrease the average voltage across capacitor (C1). This circuit acts as follows: a voltage divider consisting of resistors (A1 R15 and A1 R23) is connected between the + 15 VDC source and the collectors of the series regulators (A2) and (A3). The junction of these resistors (A1 R15 and A1 R23) is connected to the base of transistor (A1 Q10) whose emitter is tied to the negative output terminal of the supply. If the storage voltage across the series regulator increases beyond the point determined by resistors (A1 R15 and A1 R23) the transistor (A1 Q10) is turned on. This clamps the base of transistor (A1 Q11) to the negative output of the supply cutting off its drive current to the series regulators. This action decreases current flow from the series regulator (A2) and (A3) to a very low value until the controlled rectifier decreases the average value of voltage across capacitor (C1). This action keeps the dissipation of the series regulators at a safe value at all times. This circuit overrides the current limiting circuitry during overload conditions on the output of the power supply and is designed to protect the series regulator power transistors.

3.20 Power supply turn-off transient overshoots are prevented by means of a crowbar circuit assembly (A6) consisting of diodes CR1, 2, 3, and resistor (R1). When the supply is de-energized, it is possible under light load conditions for the unregulated capacitor voltage at C1 to remain charged for a relatively long interval. The voltage at C6 will fall off much more rapidly, however, since the capacitance is much smaller. Consequently, shortly after power is removed, the gate of the SCR (A6 CR2) will trigger and turn-on the SCR. This will quickly discharge the main capacitor bank C1 through (A6 CR1), (A6 R1) and the SCR (A6 CR2). In addition, the firing circuit to the main SCR's is also decoupled by (A6 CR3) and (A6 R2) during the turn off transient interval. The output capacitor energy is also discharged by the crowbar network in conjunction with diode (A3 CR1) across the pass transistors.



NOTES:

1. REPRESENTATIVE COMPONENTS SHOWN.
2. RETURNS OF DC PATHS NOT NECESSARILY SHOWN.
3. LINE LEGEND:
   - ——— POWER PATH
   - --•-- PRIME REG. PATH
   - ——— SECONDARY DC PATH
4. (A7R1) IN SOME MODELS.

SIMPLIFIED BLOCK SCHEMATIC

FIG. 3-1

SECTION IV

MAINTENANCE

4.1 GENERAL: Reference drawings for this power supply are provided in Section V. The exact Schematic Drawing is shown in Figure 5-1. Physical location of components is indicated in the Parts Placement Drawing in Figure 5-2.

This supply is designed for stable operation over long periods of time. However, if trouble develops, standard test equipment normally found in the Electronics Laboratory would be required. If the customer decides to do complete servicing on his premises, one or more of the following pieces of test equipment are required:

Instrument	Range	Remarks
DC Differential Voltmeter	0-500V	Precise Regulation check
Oscilloscope	General Purpose	General troubleshooting
Vaccuum Tube Voltmeter	General Purpose	Ripple measurements
Multimeter (Ohmmeter)		General troubleshooting
AC Voltmeter (precision)	0-150V	Precise regulation check
Variable Autotransformer	Per input rating	General troubleshooting
Dummy Load	Range depends on supply rating	

WARNING!!!

THE POWER SUPPLY SHALL BE DE-ENERGIZED WHENEVER ANY COMPONENTS ARE REPLACED.

.2

4.2.1 PREVENTATIVE MAINTENANCE: The principal item that will require attention is the cooling arrangement. All supplies depend upon convection and conduction cooling for proper operation; and supplies equipped with internal blowers depend upon forced air cooling for proper operation in addition to conduction and convection cooling. Cooling efficiency will be reduced when the supplies are operated in a dust-laden environment, and it is therefore recommended that the supplies be periodically cleaned in order to maintain proper operation.

CAUTION!!

VACUUM CLEANER MAY LOOSEN THE SMALL PLUG-IN TRANSISTORS ! ! ! !

4.2.2 PROCEDURE FOR OILING THE ROTRON MUFFIN FAN: The fan (where provided) may require oil if operated under extreme environmental conditions. The fan incorporates the latest electrical and mechanical advances in the motor design and offers reliable performance for 2 to 5 years under favorable conditions of temperature and vibration without the necessity of oiling. Its life is in inverse proportion to these factors. For example, at 110°F the fan may be expected to give reliable performance in excess of three years and at 40°F reliable performance is extended beyond five years.

If the power supply (equipped with fans) should be installed in areas of greater heat, or severe vibration, the life of the fan may be extended by periodic oiling (a small amount once per year) which is absorbed by the bearing. For this oiling procedure, an OIL INJECTOR, NJE Part No. 021988 is required and may be ordered from NJE Corporation. This OIL INJECTOR will service from 15 to 20 fans. For refills, order Fan Lubricant, NJE Part No. 020923 in 4 oz. cans.

Procedure:

Step 1: Remove cap from end of OIL INJECTOR.

Step 2: Place needle at the center of circle marked on the Gold Label.

Step 3: Position the needle at an angle of approximately 45° to the surface of the label and tangent to the perimeter of the circle.

Step 4: Pierce the label and the concealed self-sealing rubber cap located under the label.

Step 5: Insert the needle approximately 1/4".

Step 6: Depress the plunger of the OIL INJECTOR slowly to the next calibration mark which will allow 1/16" of oil to escape.

NOTE: It is better to give a little more oil than not enough. However, do not overflow the well. If the ambient temperatures are extremely hot, it may be advisable to oil more frequently to insure the optimum performance characteristics of the fan.

4.3 MEASUREMENTS AND TESTS:

4.3.1 Sensing Connection: Sensing lead connections are of utmost importance in making proper regulation measurements. It is recommended that the sensing connections be made directly at the output terminal points rather than at a remote load point. Although the regulation measurement should check correctly at a remote point as well as at the supply terminals, it is well to ascertain that the power supply itself is operating properly without introducing the possibility of extraneous external wiring problems. Thus, all measurements should be made with "local" sensing connections, i.e., with the sensing terminals jumpered directly to the corresponding output terminals. One other point of caution in proper measurement technique is the following:

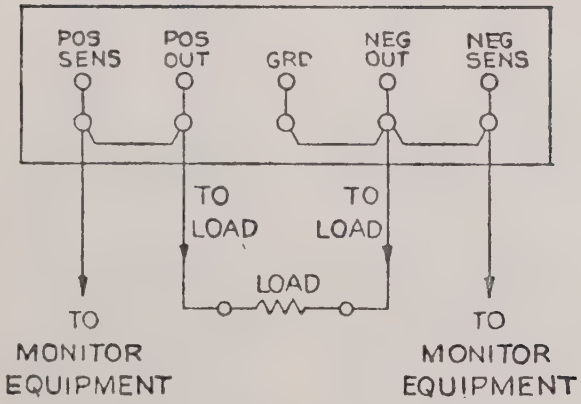
> It is absolutely essential that the measuring equipment connections be made directly to the sensing terminals, whereas the load lead connections must be made directly to the output terminals. Figure 4-1 shows proper and improper connections for measurements taken with "local" and "remote" sensing connections.

Various measurements can be made using essentially the same connections, but using different instrumentation. The following paragraphs describe the basic parameters which may be tested.

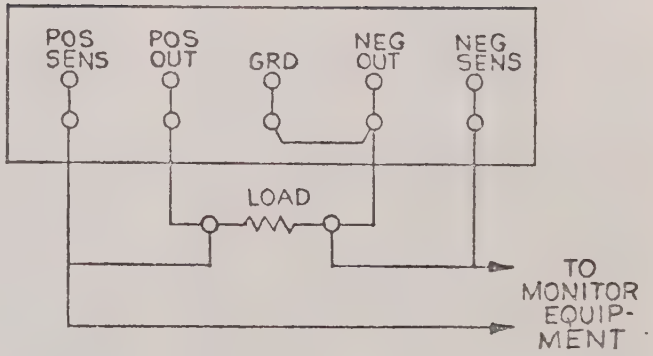
4.3.2 Regulation checks: Since regulation of modern power supplies can be as low as 0.001%, special measuring techniques must be employed to accurately check the various regulation parameters. It is necessary to use an external source of DC voltage of approximately the same value as the power supply output as a "bucking" source, connected as shown in Figure 4-2. This DC bucking voltage can be either an electronic, null balance differential voltmeter, or a group of batteries connected in series (or another power supply), furnishing a DC potential slightly larger than the output voltage of the power supply under test. When using a differential voltmeter, the voltmeter is built right into the test equipment. When a "bucking" battery is used, the voltmeter should have a full-scale range low enough to detect the magnitude of regulation expected.

A multi-tester used on the 1 volt range will usually be adequate, since approximately 10 millivolts can be observed reasonably well. The point to note here is that the voltmeter is used to measure only the difference between two almost equal voltages. The balance adjustment (either in the electronic unit, or the test set-up of the diagram) is used to bring the meter needle to approximately midscale before testing, so that the deviation above or below the normal output fo the supply under test can be observed.

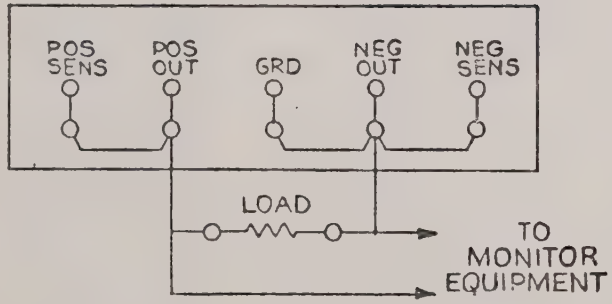
CORRECT



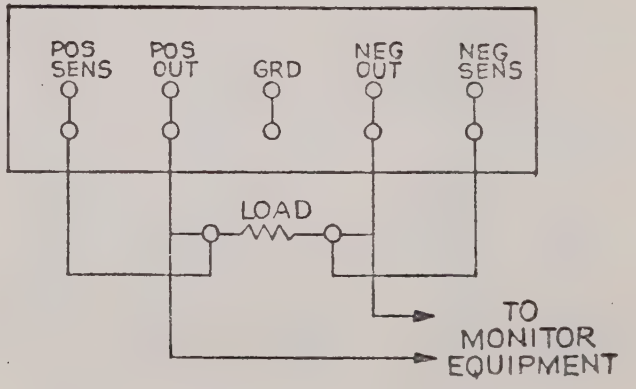
CORRECT



INCORRECT



INCORRECT



LOCAL SENSING

REMOTE SENSING

MEASUREMENT CONNECTIONS WITH LOCAL SENSING AND REMOTE SENSING

801580

FIG. 4-1

103881

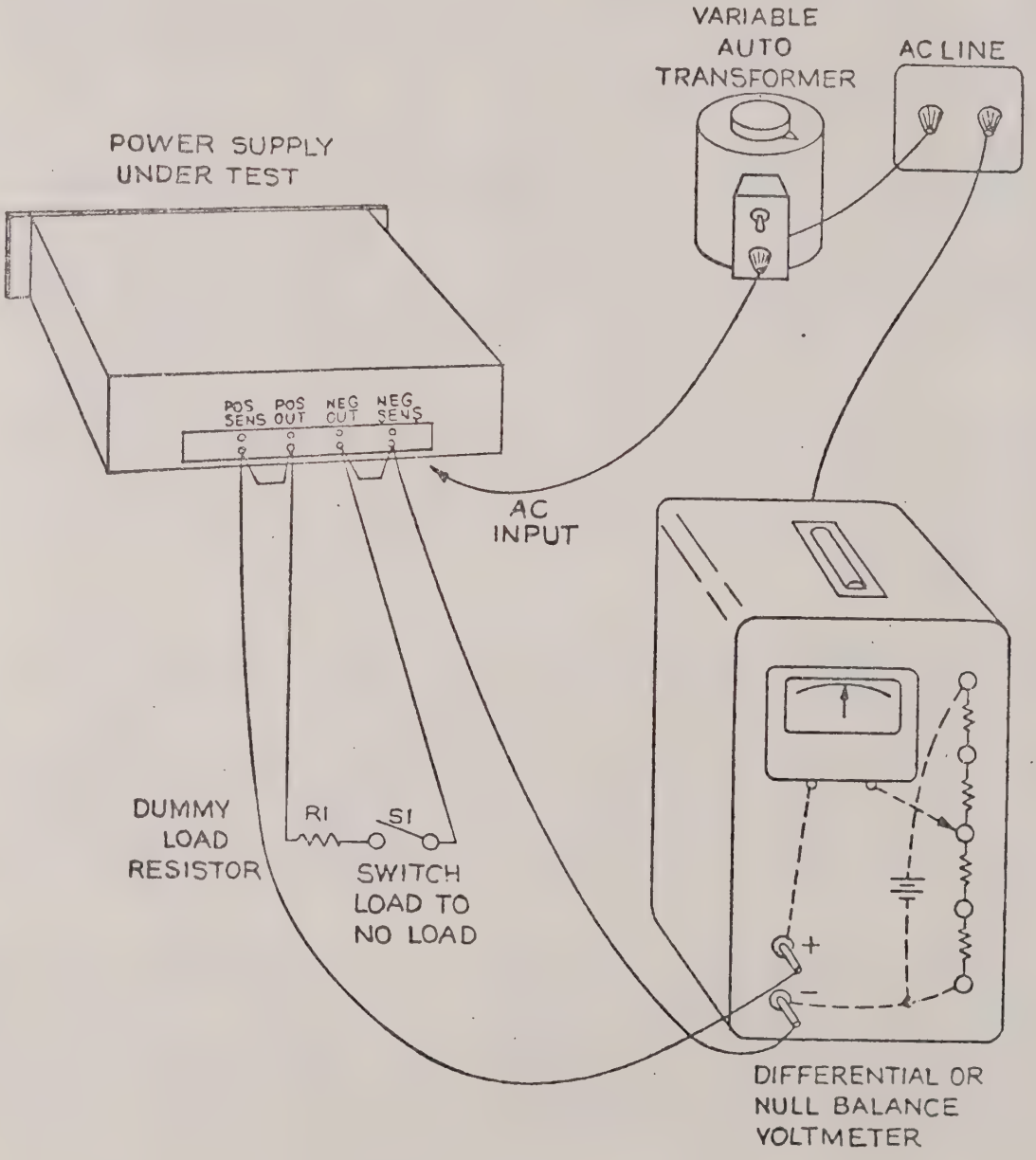
4.3.3 Static Load Regulation: The dummy load (R1) of Figure 4-2 is selected to draw full load current at the nominal output voltage of the supply. The difference between the differential voltmeter readings with the switch open and closed (allowing the needle to come to rest before reading), gives the static load regulation in volts. When load changes are made, it may be necessary to readjust the line voltage to its nominal value.

4.3.4 Static Line Regulation: With the load set at some fixed value, either no load, full load, or some in-between point, the input line is varied by means of the variable auto-transformer shown in Figure 4-2. Note that if this measurement is made under a heavy load condition, the auto-transformer must be selected to supply the necessary input volt-amperes. The difference between the differential voltmeter reading for different line voltage conditions (allowing the needle to come to rest before reading), gives the static line regulation in volts.

4.3.5 Ripple: Either a sensitive VTVM or oscilloscope may be connected directly across the power supply sensing terminals for this measurement. The same set-up is used for the regulation checks may be used if it is desired to observe the ripple under different conditions of the voltage and load current. Be sure to make the measurement connections at the sensing terminals rather than at the load terminals.

4.3.6 Dynamic Regulation and Recovery Time: In the test set-up described above for Static Load or Line Regulation, a calibrated oscilloscope should be substituted for the differential voltmeter. Maximum deflection and recovery time are measured directly, as a dummy load of appropriate value is switched in and out of the circuit. A mercury switch is recommended to minimize arcing, or else an electronic switch should be used. If available, the latter is highly desirable, since the response is readily displayed on the oscilloscope. If the rise and fall time of the current step be at least five times faster than the anticipated recovery time.

4.3.7 Stability: A detailed check for improper drift and intermittent failure can be made by utilizing the same test arrangement as for static regulation measurements. The only requirement is that the differential voltmeter used must have stability of an order of magnitude better than that of the power supply. If available, a stable recorder may be substituted for the differential voltmeter in the drawing, thereby procuring a continuous tracing of the power supply stability.



REGULATION CHECK
TYPICAL LAYOUT

FIG. 4-2

4.4 TROUBLESHOOTING: There are various types of trouble possible with this supply. The following procedure diagnoses the most likely types of trouble.

CAUTION: The sensing terminals (TB1-7 and TB1-12) must always be crossconnected to the output voltage. Failure to observe this rule will result in catastrophic failure of the power supply.

NO OUTPUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Fuse blown	Shorted component	Check the unregulated DC sources (Main and Aux)and localize trouble.
Fuse not blown	Defective transistor or component in trigger amplifier	Check if SCR has been "turned off" by trigger amp (A1 Q1).

LOW VOLTAGE OUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Voltage movable	Defective reference diode	Perform stability tests on Par. 4.6.
Voltage stable	Defective component on PC subassembly	Check if SCR has been partially "turned on" by trigger amp.
		Check storage voltage across series pass transistors and if high, check error amp.

HIGH VOLTAGE OUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Constantly high voltage	Defective component on PC subassembly	Check if SCR has been permanently "turned on" by trigger amp.
		Check storage voltage across series pass transistors. If low, check error amp.

NO REGULATION

SYMPTOM	POSSIBLE CAUSE	REMARKS

Do not operate unit until the sensing terminals are checked for proper connections.

POOR REGULATION

SYMPTOM	POSSIBLE CAUSE	REMARKS
Regulation poor under load or line changes	Defective transistor or component on PC sub-assembly	

4.5 ALIGNMENT AND ADJUSTMENT: The power supply has several controls that are factory adjusted and normally do not require attention in the field. If any of the components in the error-difference amplifier are replaced or the ammeter requires calibration the following readjustment procedure may be necessary.

4.5.1 OUTPUT ADJUST calibration.

Step 1: Set OUTPUT ADJUST variable resistors (R4 A and B) completely clockwise. The unit may be operated at nominal line and at no load.

Step 2: Place calibrated voltmeter across output.

Step 3: Adjust variable resistor (A1 R38) until full rated output is reached.

4.5.2 CURRENT CONTROL calibration.

Step 1: Set OUTPUT ADJUST variable resistors(R4 A and B) completely clockwise.

NOTE: Verify that the output is the full rated voltage.

Step 2: Set CURRENT CONTROL variable resistor (R5) completely clockwise.

Step 3: Short circuit output through a calibrated ammeter.

Step 4: Slowly rotate variable resistor (A1 R40) until current level reaches rated value.

4.5.3 AMMETER calibration.

NOTE: Applicable to units with meters.

Step 1: Set OUTPUT ADJUST variable resistors(R4 A and B) completely clockwise.

4.5.3 (cont'd)

Step 2: Set CURRENT CONTROL variable resistor (R5) completely clockwise.

Step 3: Short circuit output through a calibrated ammeter.

Step 4: Adjust AMMETER CALIBRATION ADJUST . . until unit meter agrees with external calibration meter.

4.5.4 STORAGE ADJUST: (RVC 36-5 Models only)

Step 1: Set and load power supply to rated voltage and current.

Step 2: Monitor the voltage across one of the series pass transistors with an ordinary multi-tester. Printed board terminals 15 and 13 are readily accessible and may be used as the positive and negative meter connection points, respectively.

Step 3: Adjust STORAGE ADJUST potentiometer (A1 R25) for a reading of 5.0 Volts DC on the monitor voltmeter.

4.6 ERROR-DIFFERENTIAL AND SECONDARY REGULATION AMPLIFIER CHECK: There are several methods which can be used in checking the performance and condition of these amplifiers.

Except for individually removing the transistors for a check by means of a transistor test set, and making continuity and resistance tests on the circuit and components, all methods require the amplifier to be energized with the proper potentials under the conditions found in the power supply for normal operation. For this reason, it is simplest to test the amplifier in position in the supply, first making certain that the unregulated DC bias sources are functioning properly. This can be quickly ascertained by checking the circuit voltages on the schematic diagram Figure 5-1. Once this is done, the procedure given below can be used to check out the amplifiers.

4.6.1 Signal Tracing Check: Since there is an inherent amount of ripple at the input of the amplifiers, this ripple signal can be used as a test signal for observing the amplifier performance with the aid of a test oscilloscope. (Ignore any spikes in the waveform). Use only the basic ripple signal when making amplitude calculations. In the event that the ripple is too small for practical use, a small 60-cycle sine wave voltage of convenient amplitude (less than 0.1 volt) can be injected into the amplifier by applying it to the base of the input transistor (A1 Q15) on the printed circuit board. Measurement of the ripple at the input to the amplifier, and at the output of each successive amplifier stage will

provide an effective check of amplifier performance. The ripple amplitude measured at the base (or input) of the second stage transistors (A1 Q12 and A1 Q13) should be 40 to 100 times the amplitude at the input to the first stage. Radical departure from this set of conditions will point up a defective component or connection, which can then be isolated by inspection and individual test. Be sure not to overdrive the amplifier stages as it will cause misleading results. This process can be continued until the emitter follower stages are reached. At this point the circuitry undergoes an impedance transformation and no voltage gain will be noted. Instead a decrease in amplitude will be noted.

4.7. STABILITY CHECK: A detailed check for improper drift and intermittent failure can be made by utilizing a test arrangement similar to that shown for regulation check in Figure 4-2.

NOTE: Observe polarity of setup as required.

The voltage across the breakdown diode reference sources may be "bucked out" and monitored by a 0 to 10 millivolt (or smaller scale, if available) high impedance DC voltmeter (null balance voltmeter). Drift or random instability will be readily visible in this test. Output voltages of the successive amplifier stages can then be monitored in the same manner. When checking a given amplifier stage by this method the output of the previous stage should be shorted, to prevent external voltage variations from reaching the stage under test. This does not include shorting the output terminals of the power supply. Care must be exercised to guard the load circuit from extraneous fields. When installing a new transistor in place of one shown to be defective, the stability check should be repeated to make certain that the trouble has been eliminated.

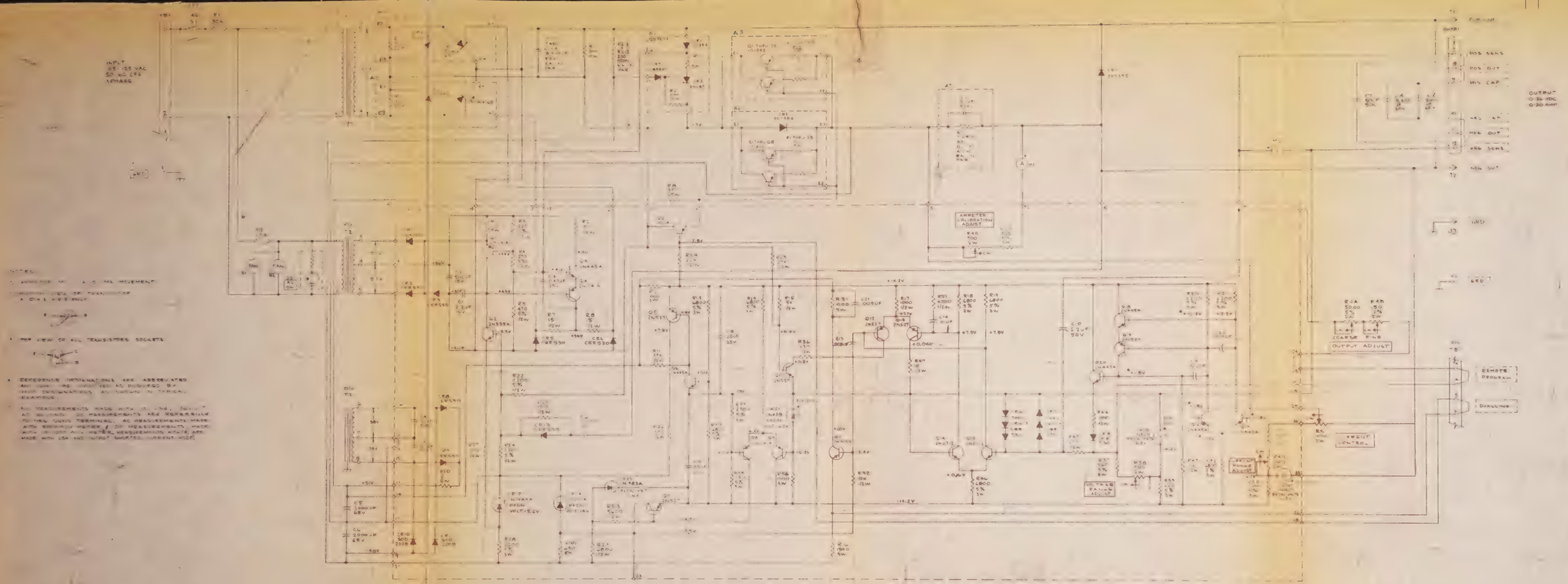
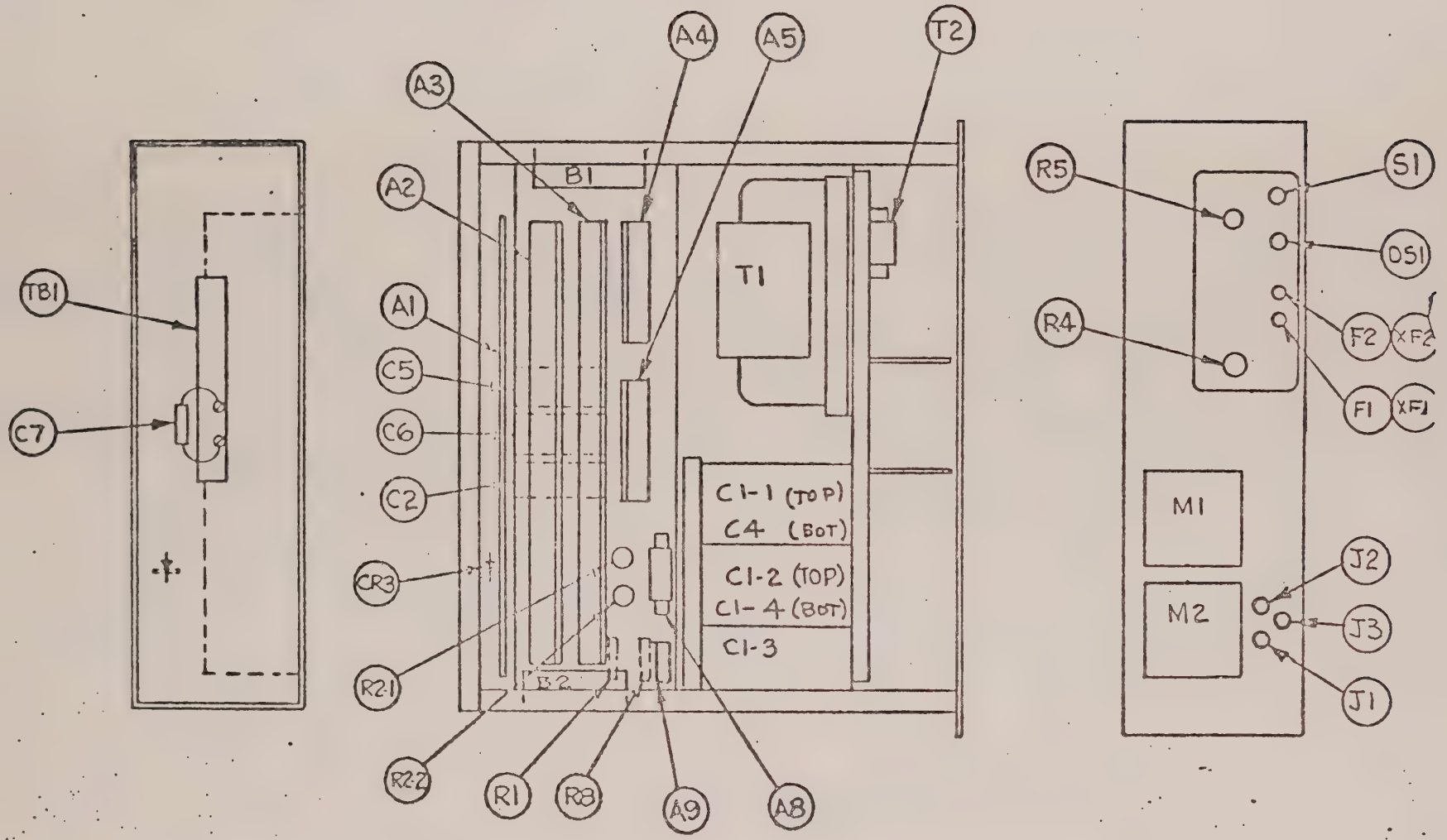


FIG. 5-1A
SCHEMATIC DIAGRAM

403404

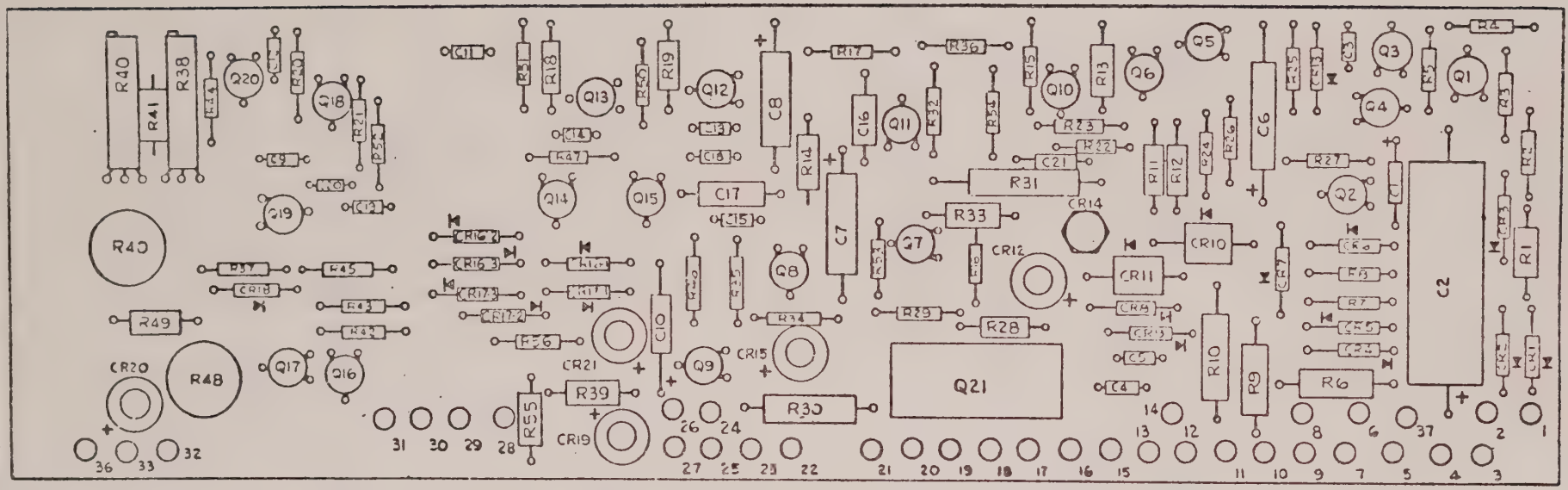
		CS-3UCR30	NJE CORPORATION FRANKLIN PARK, N.J.
			SIZE A DWG. NO. 7011

403404



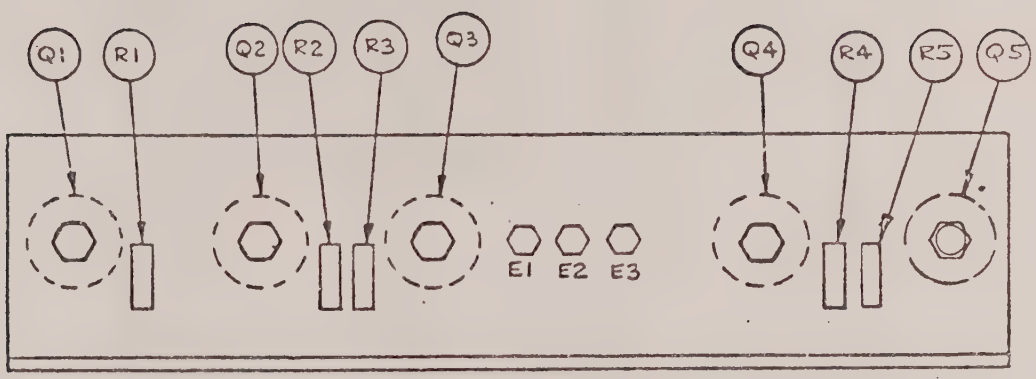
PARTS PLACEMENT - MAJOR COMPONENTS
FIG. 5-2A

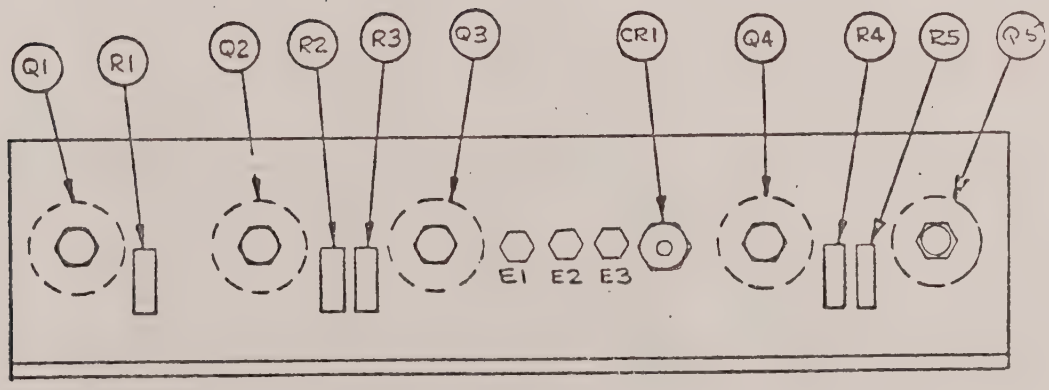
104583



PARTS PLACEMENT - 114 PC
FIG. 5-2B

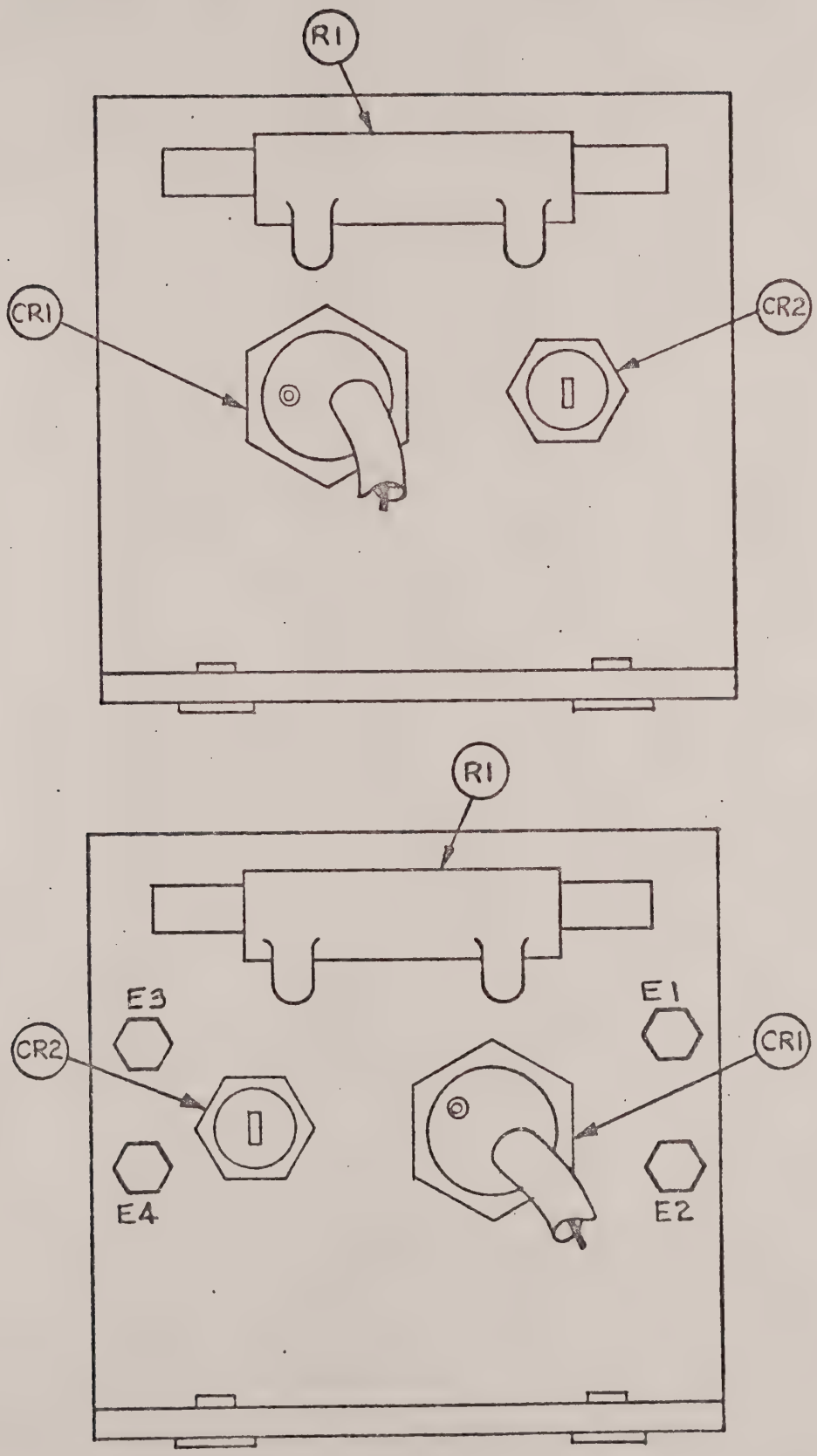
403316



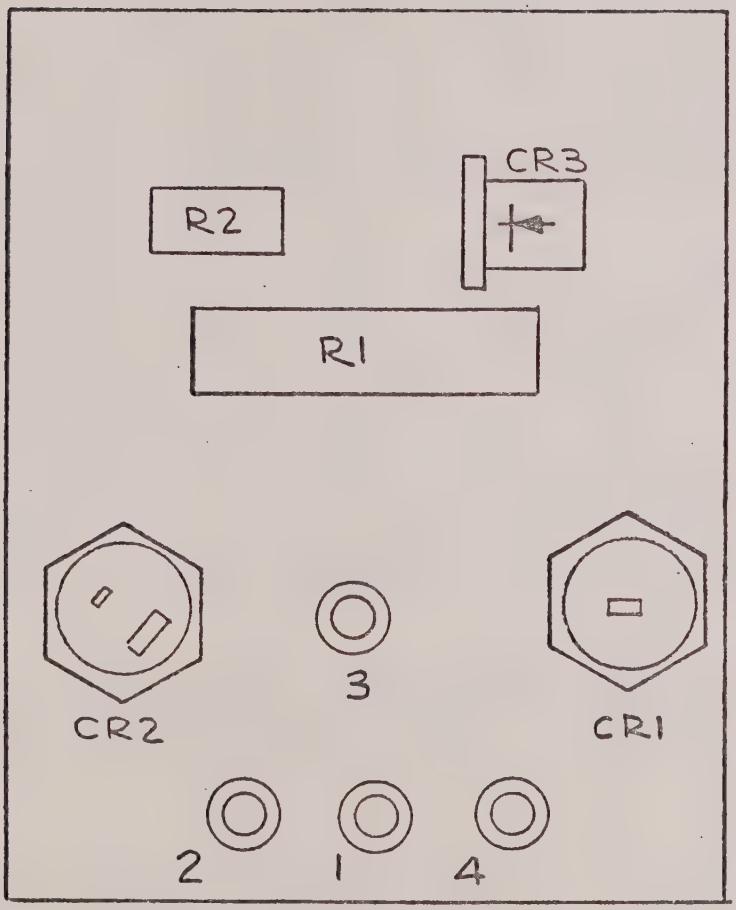


PARTS PLACEMENT - TRANSISTOR HEAT SINK

FIG. 5-2C



PARTS PLACEMENT- RECTIFIER HEAT SINKS
FIG. 5-2D



PART PLACEMENT 125PC

FIG. 5-2E

ABBREVIATIONS USED IN SPARE PARTS LIST

In DESCRIPTION Column: "SA" is used to mean "Same As" and "PO" is used to mean "Part Of". Where these symbols are used, the UNIT QTY., SPARE QTY., UNIT PRICE and NJE PART NO., columns are all blank.

In VALUE Column: The use of the letter "R" to indicate a decimal point is illustrated by the following examples: 5.6Ω is written as 5R60K. 1/2 watts is written as R500 W. The use of zeroes does not imply a precision to the indicated number of decimal places but is a requirement of the proper handling of the Data Processing Cards from which these spare parts lists are written.

The standard symbols for electrical units are used and usually appear in the columns immediately to the left of the dashed and solid lines in the Value field. In all cases, the symbol "Ω" is not printed for resistors and is understood. For example: 200Ω is written 200 and 2.7MΩ is written 2R70M.

In REFERENCE DESIGNATION Column: The reference designations are those which interrelate the Spare Parts List, the Schematic Diagrams and the Parts Placement drawings. The symbols are those of MIL-STD-16. Where the reference designation is an "A" (meaning a sub-assembly), a Spare Parts List bearing the NJE Part Number of that assembly is included in the Spare Parts List section.

Deviations: Where minor deviations are accomplished by modifying a standard unit, a Spare Parts List which only shows the deletions and additions from the enclosed standard Spare Parts List is used.

N J E Corp. KENILWORTH, N.J.

Spare Parts List

MODEL CS 36CR30-D2 P/N 83848

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.
	THE SPARE PARTS				
	LIST FOR THIS				
	UNIT IS THE SAME				
	AS THAT USED FOR				
	CS-36CR30 EXCEPT				
	FOR THE FOLLOW-				
	ING.				
	ADD:				
1	SLIDE ASSEMBLY	PAIR	110288	1 set	1 set

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
2 - Unit Price shown above is subject to change without prior notice.
3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
4 - Spare Quantity shown above is recommended quantity for one year isolated service.

N J E Corp. KENILWORTH, N.J. — Spare Parts List

MODEL CS36CR30 — 82158 — PAGE NO.

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.
A1	114PC 2	PC ASSY		82177	1	1
A2	XISTOR HEAT SINK	HS ASSY XISTER		82180	1	1
A3	XISTOR HEAT SINK	TRANS HS ASSYY		82279	1	1
A4	RECT HEAT SINK	RECT H S ASSY		81994	1	1
A5	RECT HEAT SINK	RECT H S ASSY		81995	1	1
A6	125PC 1	CKT CARD ASSY		82129	1	1
B1	BLOWER 60 CPS	115V 1PH	5IN	2	2	1
B2	SA B1					
C1 1	CAP FXD ELECT	18500UF	50 V	107365	5	2
C1 2	SA C1 1					
C1 3	SA C1 1					
C1 4	SA C1 1					
C2	CAP FXD ELECT	2000UF	65V	107366	3	1
C3	CAP FXD CERAMIC	R1UF	500 V	167	1	1
C4	SA C1 1					
C5	SA C2					
C6	SA C2					
C7	CAP FXD ELECT	50UF	50 V	20812	1	1
CR1	DIODE RECTIFIER S	35 A	200 V	207395	1	1
DS1	PILOT LAMP	T3	R250 W	24	1	1
F1	FUSE CARTRIDGE	20R00 A	250 V	234	1	5
F2	FUSE CARTRIDGE	1R00 A	125 V	229	1	5
J2	CONNECTOR RECEPT	1 PIN	30 A	32	2	
J1	CONNECTOR RECEPT	1 PIN	30 A	33	1	
J3	SA J2					
M1	AMMETER DC	30R0 A	1MA	105520	1	1
M2	VOLTMETER DC	40R0 V		47	1	1
R1	RES FXD WW	300R00	10 W	1376	1	1
R2 1	RES FXD WW	200R00	50 W	91	2	1
R2 2	SA R2 1					
R3 1	RES FXD WW	R10	40 W	105527	3	1
R3 2	SA R3 1					
R3 3	SA R3 1					
R4	DUAL POT	5R0K&150	223	105123	1	1
R5	RES VAR WW	1R00 K	2 W	150	1	1
R8	RES FXD WW	300R00	25 W	1454	1	1
S1	SWITCH TOGGLE	SPST	15 A	121	1	1
T1	TRANSFORMER			82201	1	1
T2	TRANSFORMER			207747	1	1
TS1	TERMINAL BOARD	12 TERM	30 A	122	1	
XDS1	LAMPHOLDER	RD CLEAR	125 V	105063	1	
XF1	FUSE HOLDER	30 A	250 V	20631	2	
XF2	SA XF1					
	114PC 3			82177		

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

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3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
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N J E Corp. KENILWORTH, N.J. — Spare Parts List

MODEL CS36CR30 — 82158 — PAGE NO. 2

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.
C1	CAP FXD TANTALUM	2R2UF 15 V	510	1	1
C2	CAP FXD ELECT	500UF 15 V	163	1	1
C3	CAP FXD CERAMIC	R47UF 25 V	405	1	1
C4	CAP FXD CERAMIC	R1UF 500 V	167	2	1
C5	SA C4				
C6	CAP FXD ELECT	50UF 15 V	462	1	1
C7	CAP FXD ELECT	25UF 25 V	664	2	1
C8	SA C7				
C9	CAP FXD CERAMIC	R22UF 25 V	20759	1	1
C10	CAP FXD TANTALUM	2R2UF 50 V	20039	1	1
C11	NOT USED				
C12	NOT USED				
C13	CAP FXD CERAMIC	5000PF 1KV	21787	3	1
C14	CAP FXD CERAMIC	10000PF 150 V	323	1	1
C15	NOT USED				
C16	NOT USED				
C17	NOT USED				
C18	NOT USED				
C19	NOT USED				
C20	SA C13				
C21	SA C13				
CR1	DIODE RECTIFIER S	750MA 300 V	135	15	4
CR2	SA CR1				
CR3	SA CR1				
CR4	NOT USED				
CR5	SA CR1				
CR6	SA CR1				
CR7	NOT USED				
CR8	SA CR1				
CR9	SA CR1				
CR10	DIODE RECTIFIER S	2 A 200 V	103232	2	1
CR11	SA CR10				
CR12	DIODE BKDOWN 10PC	150MW 5R6 V	135	2	1
CR13	SA CR1				
CR14	DIODE BKDOWN 10PC	10 W 18 V	102014	1	1
CR15	SA CR12				
CR16-1	SA CR1				
CR16-2	SA CR1				
CR16-3	SA CR1				
CR17-1	SA CR1				
CR17-2	SA CR1				
CR17-3	SA CR1				
CR18	SA CR1				
CR19	DIODE BKDOWN 5PCT	250MW 6R2 V	130	3	1
CR20	SA CR19				
CR21	SA CR19				

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

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MODEL CS36CR30 82158 PAGE NO. 3

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.
Q1	TRANSISTOR PNP SI	20 MW 25 V	139	4	1
Q2	TRANSISTOR NPN SI	150MW 45 V	4159	1	1
Q3	TRANSISTOR NPN GE	150MW 18 V	142	6	2
Q4	SA Q1				
Q5	TRANSISTOR PNP SI	225MW 30 V	20692	6	2
Q6	SA Q3				
Q7	SA Q5				
Q8	SA Q1				
Q9	SA Q1				
Q10	SA Q5				
Q11	TRANSISTOR NPN SI	4 W 60 V	5255	1	1
Q12	SA Q5				
Q13	SA Q5				
Q14	TRANSISTOR NPN SI	200MW 18 V	21711	2	1
Q15	SA Q14				
Q16	SA Q3				
Q17	SA Q3				
Q18	SA Q3				
Q19	SA Q5				
Q20	SA Q3				
Q21	TRANSISTOR PNP SI	10 W 55 V	102141	1	1
R1	RES FXD WW	100R00 3 W	263	1	1
R2	RES FXD COMP	15R00 R500 W	177	3	1
R3	RES FXD COMP SPCT	220R00 R500 W	182	1	1
R4	RES FXD COMP SPCT	270R00 R500 W	183	1	1
R5	RES FXD COMP SPCT	470R00 R500 W	184	1	1
R6	NOT USED				
R7	SA R2				
R8	SA R2				
R9	NOT USED				
R10	RES FXD WW	2R00 5 W	368	1	1
R11	RES FXD COMP	33R00 KR500 W	243	1	1
R12	RES FXD WW	1R00 K 3 W	1649	3	1
R13	RES FXD WW SPCT	6R20 K 3 W	1667	7	1
R14	SA R13				
R15	RES FXD COMP	15R00 KR500 W	67	1	1
R16	RES FXD WW	1R50 K 3 W	5050	1	1
R17	RES FXD COMP SPCT	1R00K R500 W	451	3	1
R18	SA R13				
R19	SA R13				
R20	RES FXD WW	2R20 K 3 W	1656	2	1
R21	SA R20				
R22	RES FXD COMP SPCT	2R20K R500 W	1024	3	1
R23	RES FXD COMP	27R00 KR500 W	21807	1	1
R24	SA R22				
R25	RES FXD COMP	150R00 R500 W	55	1	1

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

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MODEL CS36CR30 82158 PAGE NO. 4

REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.
R26	RES FXD COMP	390R00 R500 W	985	1	1
R27	SA R17				
R28	SA R22				
R29	RES FXD COMP	6R50 KR500 W	450	1	1
R30	RES FXD WW	650R00 5 W	1705	1	1
R31	RES FXD WW	1R00 K 5 W	1707	1	1
R32	RES FXD COMP	10R00 KR500 W	65	2	1
R33	SA R13				
R34	RES FXD WW	3R30 K 3 W	1661	1	1
R35	RES FXD WW	2R70 K 3 W	1659	1	1
R36	RES FXD COMP	330R00 R500 W	180	1	1
R37	RES FXD WW	560R00 3 W	54	1	1
R38	RES VAR WW	500R00 R250 W	115	1	1
R39	RES FXD WW	620R00 3 W	1640	1	1
R40	RES VAR WW	1R00 K 2 W	107643	1	1
R41	RES FXD WW	4R70 K 3 W	97	1	1
R42	SA R13				
R43	SA R32				
R44	SA R17				
R45	RES FXD COMP	270R00 R500 W	56	1	1
R46	SA R13				
R47	RES FXD COMP	10R00 R500 W	975	1	1
R48	RES VAR WW	500R00 2 W	107AA1	1	1
R49	RES FXD WW	750R00 3 W	1644	1	1
R50	NOT USED				
R51	RES FXD COMP SPCT	4R70K R500 W	186	1	1
R52	NOT USED				
R53	RES FXD COMP	5R60 KR500 W	65	1	1
R54	RES FXD COMP SPCT	22R00 KR500 W	1027	1	1
R55	SA R12				
R56	SA R12				
XQ1	SOCKET TRANSISTOR	4PIN	128	20	
XQ2	SA XQ1				
XQ3	SA XQ1				
XQ4	SA XQ1				
XQ5	SA XQ1				
XQ6	SA XQ1				
XQ7	SA XQ1				
XQ8	SA XQ1				
XQ9	SA XQ1				
XQ10	SA XQ1				
XQ11	SA XQ1				
XQ12	SA XQ1				
XQ13	SA XQ1				
XQ14	SA XQ1				
XQ15	SA XQ1				

*SPARE PARTS LIST SPECIFYING TYPICAL VENDOR'S NAME AND PART NUMBER IS AVAILABLE ON SPECIAL ORDER ONLY.

1 - When ordering spare parts it is necessary to specify the serial number and model number (available on the warranty label on the rear of the unit) and the NJE Part No. from this spare parts list.
2 - Unit Price shown above is subject to change without prior notice.
3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
4 - Spare Quantity shown above is recommended quantity for one year isolated service.

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REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*		NJE PART NO.	QTY. USED	SPARE QTY.
XQ16	SA XQ1					
XQ17	SA XQ1					
XQ18	SA XQ1					
XQ19	SA XQ1					
XQ20	SA XQ1					
XQ21	SOCKET TRANSISTOR	2PIN		2543	1	
	HS ASSY XISTER			82180		
Q1	TRANSISTOR PNP GE	50 W	55 V	101892	5	2
Q2	SA Q1					
Q3	SA Q1					
Q4	SA Q1					
Q5	SA Q1					
R1	RES FXD WW	R20	5 W	99	5	2
R2	SA R1					
R3	SA R1					
R4	SA R1					
R5	SA R1					
	TRANS HS ASSY			82279		
CR1	DIODE RECTIFIER S	12 A	200 V	207394	1	1
Q1	TRANSISTOR PNP GE	50 W	55 V	101892	5	2
Q2	SA Q1					
Q3	SA Q1					
Q4	SA Q1					
Q5	SA Q1					
R1	RES FXD WW	R20	5 W	99	5	2
R2	SA R1					
R3	SA R1					
R4	SA R1					
R5	SA R1					
	RECT H S ASSY			81994		
CR1	RECTIFIER CONTROL	55 A	100 V	149	1	1
CR2	DIODE RECTIFIER S	35 A	200 V	207395	1	1
R1	RES FXD WW	100R00	25 W	80	1	1
	RECT H S ASSY			81995		
CR1	RECTIFIER CONTROL	55 A	100 V	149	1	1
R1	RES FXD WW	100R00	25 W	80	1	1
CR2	DIODE RECTIFIER S	35 A	200 V	207395	1	1

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REFERENCE DESIGNATION	DESCRIPTION VENDOR NAME*	RATINGS VENDOR PART NO.*	NJE PART NO.	QTY. USED	SPARE QTY.
	125PC 1		S2129		
CR1	DIODE RECTIFIER S	12 A 200 V	207394	1	1
CR2	RECTIFIER CONTROL	25 A 100 V	192	1	1
CR3	DIODE RECTIFIER S	750 MA 300 V	133	1	1
R1	RES FXD WW	1200 10 W	1362	1	1
R2	RES FXD 60HD 5PCT	1200K 2500 W	451	1	1

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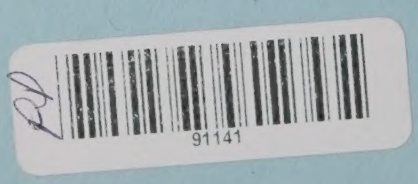
2 - Unit Price shown above is subject to change without prior notice.
3 - NJE Corp. reserves the right to make design improvements on this unit without prior notice.
4 - Spare Quantity shown above is recommended quantity for one year isolated service.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